Aviation Week

Including Space Technology

75 Cents

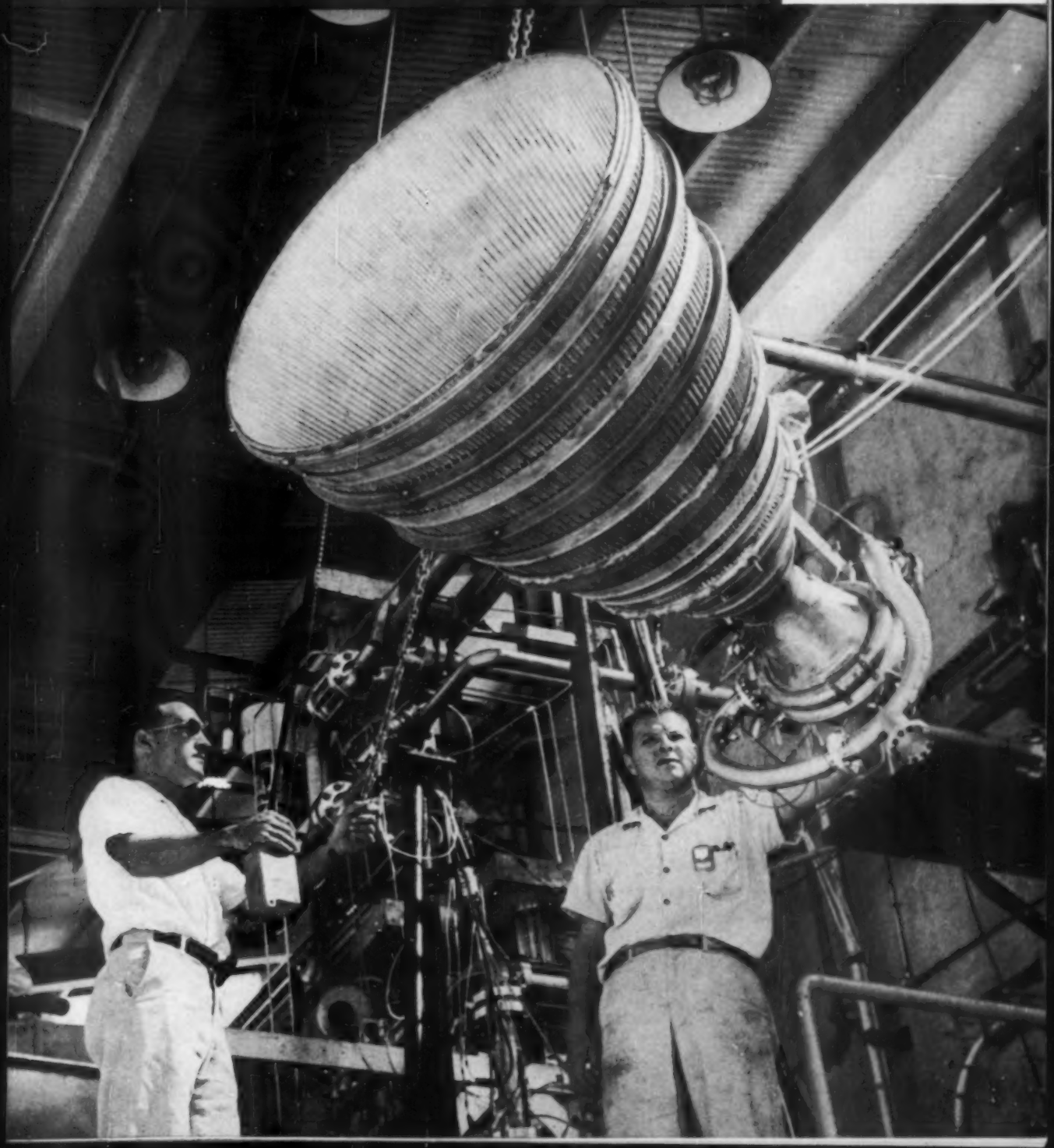
A McGraw-Hill Publication

July 27, 1959

SPECIAL REPORTS:

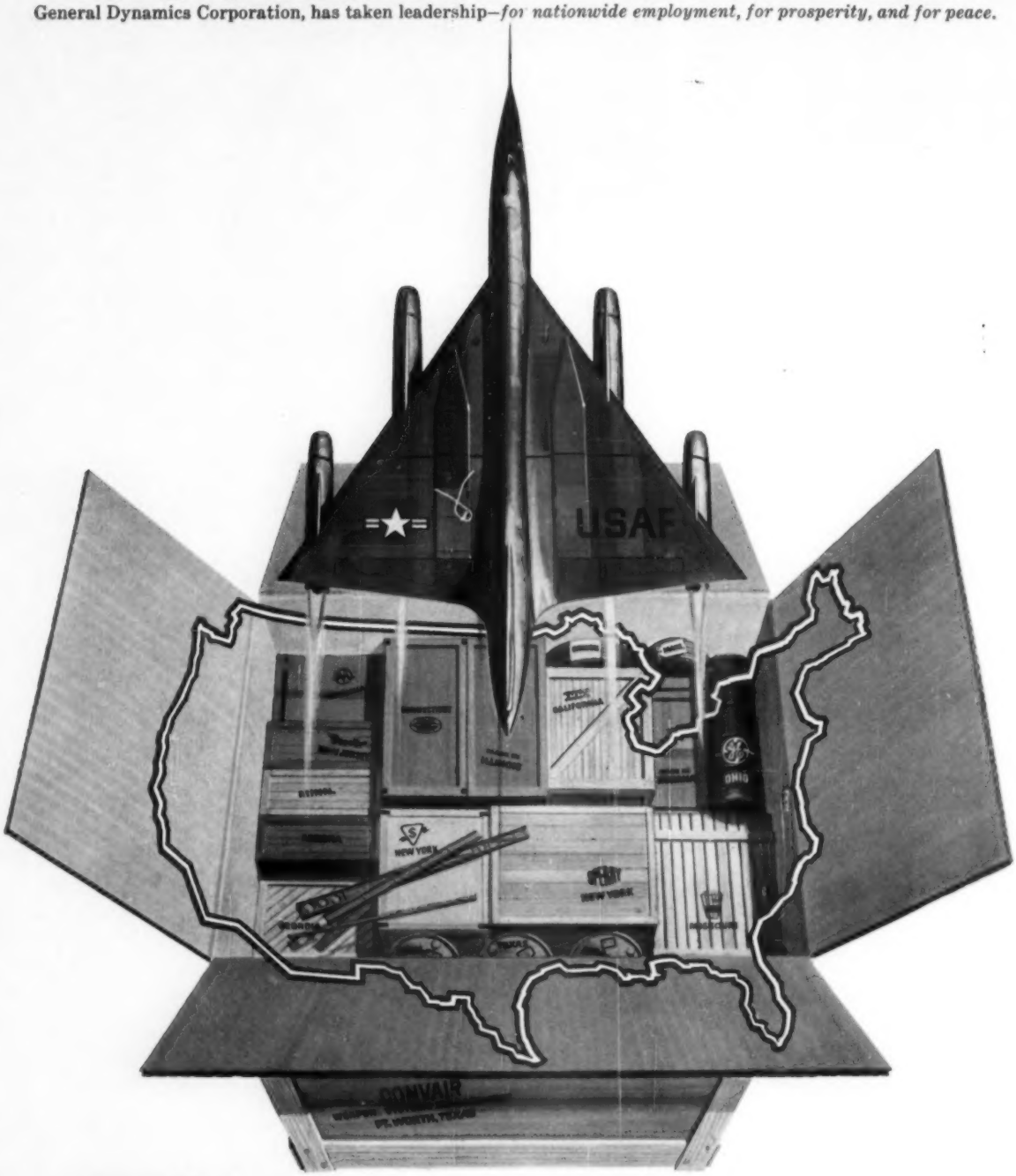
- AO-1 Design
- Maxson Radar

Pratt & Whitney Centaur Liquid Hydrogen Engine



From every part of the nation... come the parts for the B-58!

The B-58, America's first supersonic bomber, is a product of Convair and more than 4,700 participating suppliers and subcontractors *located in every part of the nation!* This does not include the tens of thousands of companies who receive business from Convair's direct suppliers. At Convair-Fort Worth under the Weapon Systems Management concept, two out of every three dollars spent for the U.S. Air Force on the B-58 are paid to these supporting businesses for material and labor. In this, the American way, Convair, a Division of General Dynamics Corporation, has taken leadership—*for nationwide employment, for prosperity, and for peace.*



CONVAIR
A DIVISION OF **GENERAL DYNAMICS CORPORATION**

BEING INTEGRATED INTO TOMORROW'S AIRCRAFT AND MISSILE SYSTEMS

NEW VICKERS Variable Displacement Hydraulic Pumps with MAXIMUM HP/LB RATIO

Model Series	Displacement cu. in./rev.	RPM		Weight lb.	HP/LB*	
		Limited Life	Rated		Limited Life	Rated
PV006	.095	18,200	12,500	2.8	4.55	3.12
PV012	.188	14,500	10,000	4.5	4.45	3.06
PV024	.367	11,600	8,000	6.9	4.53	3.13
PV039	.600	10,000	8,000	10.2	4.33	3.46
PV062	.950	8,900	7,000	14.0	4.44	3.49
PV104	1.600	7,500	5,800	19.0	4.65	3.59
PV163	2.500	6,500	5,100	26.0	4.60	3.60

***This is hydraulic output horsepower at 3000 psi**

The above table is important to anyone concerned with the selection of hydraulic pumps for future air or space vehicles. Note particularly the horsepower-to-weight ratios for both rated and limited life speeds. These are the highest known available at this time.

But highest hp/lb is only one of many advantages offered you by the new Vickers advanced design variable displacement pumps. Developed to meet the requirements of the new MIL-P-19692 specification, this new series has volumetric efficiencies of 96% to 98% over a pressure range of 500 to 3000 psi . . . and has 4000 psi continuous operation capabilities. These pumps have faster response and improved contamination resistance; they have practically the same envelope as constant displacement units of equal output. The first five sizes are now being integrated into advanced aircraft and missile systems; the two larger sizes are in the development stage. Write for Bulletin A-5233 for additional information.

Variable Hydraulic Motors using the Advanced Design Series concept are now under development.

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Aero Hydraulics Division — Engineering, Sales and Service Offices:
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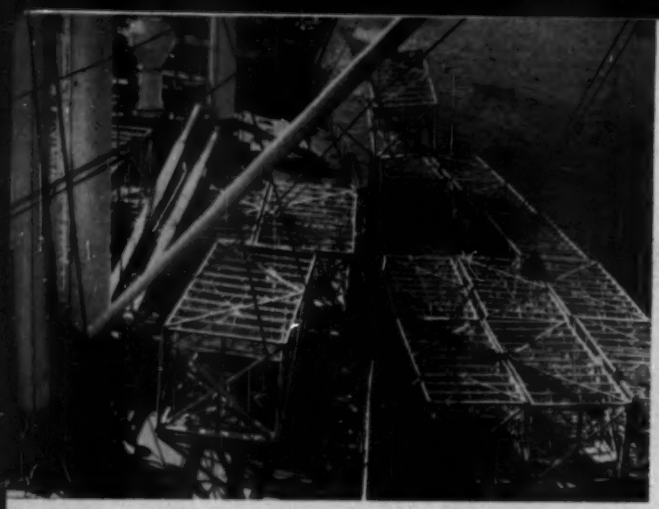
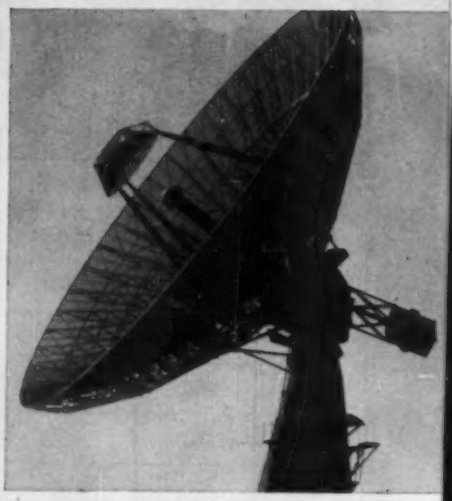
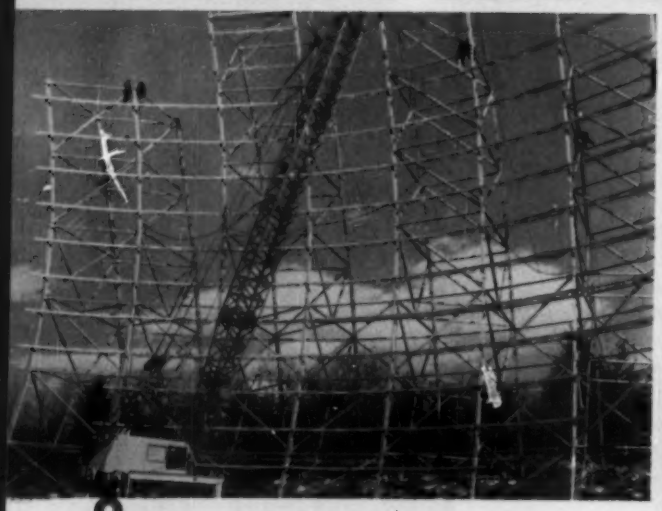
Engineers and Builders of Fluid Power Equipment Since 1921



What you should know about

KENNEDY FIELD ENGINEERING SERVICE





OVER the years Kennedy has expanded its facilities to meet the needs of the antenna industry . . . and today provides a complete field engineering service geared to solve the complex problems of antenna systems installation.

This service, conducted by thoroughly experienced Kennedy field engineers and technicians, includes site selection assembly, erection, trouble shooting and checkout, customer liasion, and on-the-job training for systems personnel in operation and maintenance.

An important fact is underlined here: that Kennedy capability in antenna systems is *total* capability.

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Down-to-earth SOLUTIONS *to out-of-this-world* PROBLEMS
Tracking Antennas-Radio Telescopes-Radar Antennas
"Trans-Horizon" Antennas-Tropospheric Scatter
Ionospheric Scatter

AVIATION CALENDAR

Aug. 4-5—Second Annual Western Regional Meeting, American Astronautical Society, Ambassador Hotel, Los Angeles, Calif.

Aug. 5-7—William Frederick Durand Centennial Conference on the problems of hypersonic and space flight, Stanford University, Stanford, Calif.

Aug. 9-12—Third National Heat Transfer Conference & Exhibit, University of Connecticut, Storrs, Conn. Sponsors: American Society of Mechanical Engineers; American Institute of Chemical Engineers.

Aug. 11-13—Wright Air Development Center Symposium on Aircraft Structural Fatigue Problems, Dayton Biltmore Hotel, Dayton, Ohio. (Confidential clearance.)

Aug. 12-14—Eighth Annual Conference on Applications of X-Ray Analysis, Stanley Hotel, Estes Park, Colo. Sponsor: Metallurgy Division, Denver Research Institute.

Aug. 17—First National Ultrasonics Symposium, Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif.

Aug. 18-21—Western Electronic Show & Convention, Institute of Radio Engineers, Cow Palace, San Francisco, Calif.

Aug. 23—Downtown Baton Rouge Exchange Club's Sky-O-Rama, Baton Rouge, La. Program includes the Blue Angels and military displays, both flying and static.

Aug. 24-26—Gas Dynamics Symposium, American Rocket Society, Northwestern University, Evanston, Ill.

Aug. 24-26—Institute of the Aeronautical Sciences' National Specialists Meeting, a symposium on anti-submarine warfare, (classified), San Diego, Calif.

Aug. 24-27—Fourth Symposium on Ballistic Missile and Space Technology, Los Angeles, Calif. Sponsors: USAF's Ballistic Missile Division; Space Technology Laboratories, Inc.

(Continued on page 6)

AVIATION WEEK Including Space Technology

July 27, 1959
Vol. 71, No. 4

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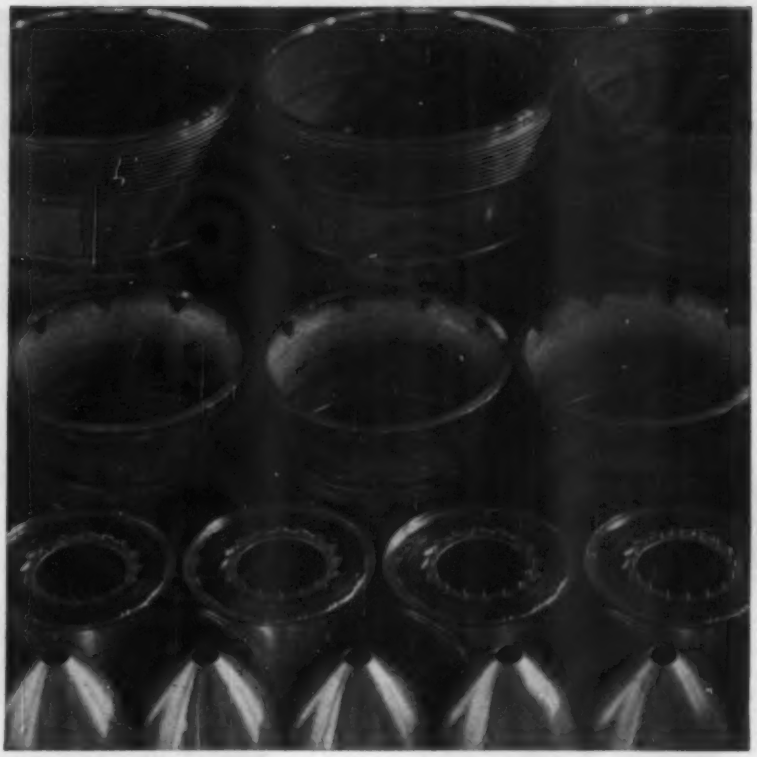


high temperature / AVIATION COMPONENTS BY LAVELLE

Lavelle manufactures aviation components to meet the most critical demands of high temperature operation. Typical of the many high temperature units produced in quantity by experienced Lavelle craftsmen are the jet engine tail pipes, engine casings and heat exchangers shown above.

Lavelle specializes in the production of precision sheet metal weldments and assemblies made of titanium, aluminum, stainless steel, and heat-resistant nickel alloys . . . joined by welding methods applicable to specific component design and function. Where required, special tools are designed and fabricated by Lavelle to maintain production quality, reduce costs . . . and promote on-schedule delivery.

If your requirements for component performance demand the very highest standards of component workmanship, call on Lavelle . . . or write for brochure describing specialized skills and facilities ready to serve your needs.

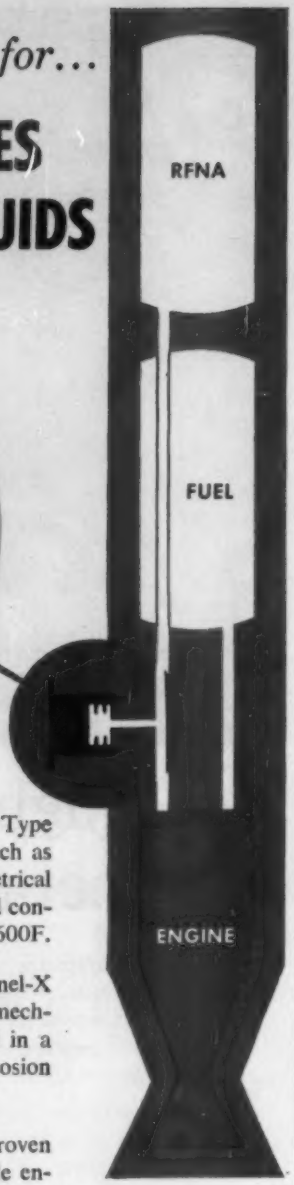
Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.
Between Philadelphia, Pa., and Trenton, N.J.

Pressure Potentiometers for...

HIGH TEMPERATURES and CORROSIVE FLUIDS

Type P103
Pressure Potentiometer
shown ¾ size



New Trans-Sonics* Pressure Potentiometers, Type P103, measure pressures of corrosive fluids such as red fuming nitric acid (RFNA) and unsymmetrical dymethylhydrazine (UDMH) for telemetry and control applications at ambient temperatures up to 600F.

Corrosive fluids are contained by a welded Inconel-X bellows which actuates a dynamically balanced mechanism. This mechanism is hermetically sealed in a stainless steel case for protection against corrosion and other environmental hazards.

Accurate and reliable performance has been proven under the following conditions typical of missile environments: *Random Gaussian Vibration* 0.1g²/cps, 15 to 2,000 cps; *Acceleration* 75g; *Shock* 75g.

Flexibility of installation is assured by small size and light weight. Dimensions are 1⅞" diameter by 1⅞" long. Weight is only 6 ounces. Standard ranges are 0-100 and 0-150 psia . . . other ranges to special order. Write for Technical Bulletin P103 to Trans-Sonics, Inc., Dept. 7, Burlington, Mass.

*TRADEMARK

TRANS-SONICS

Precision Transducers

AVIATION CALENDAR

(Continued from page 5)

Aug. 27-28—International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England.

Aug. 31-Sept. 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex.

Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 1-2—Conference on physical chemistry in aerodynamic and space flight, University of Pennsylvania, Philadelphia, Pa. Sponsors: Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Dept.

Sept. 2-4—1959 Cryogenic Engineering Conference, University of California, Berkeley, Calif.

Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences; Office of Naval Research; National Science Foundation.

Sept. 16-17—Western Regional Meeting on Frontiers on Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.

Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago, Amphitheater, Chicago, Ill.

Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.

Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 28-30—1959 National Symposium on Telemetering, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers' Professional Group on Space Electronics & Telemetry.

Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.

Oct. 5-7—Seventh Anglo-American Aeronautical Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.

Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

Oct. 6-8—12th Annual Meeting, National Business Aircraft Assn., Hotel Leamington, Minneapolis, Minn.

Oct. 6-9—International Symposium on High Temperature Technology, Asilomar Conference Grounds, Monterey Peninsula, Calif. Sponsor: Stanford Research Institute.

Oct. 8—Society of Experimental Test Pilots' Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif. Third Annual Awards Banquet, Oct. 10.

Oct. 12-14—15th National Electronics Conference, Hotel Sherman, Chicago, Ill.

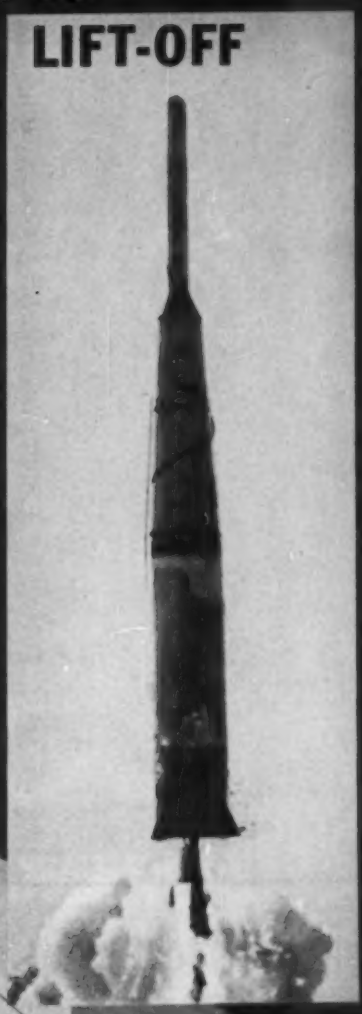
Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.

FROM LAGRANGIAN TO LIFT-OFF

Sometimes forgotten during the thundering ascent of a space probe rocket are months of meticulous analysis, engineering and planning. The staff of Space Technology Laboratories is now engaged in a broad program of space research for the Air Force, the National Aeronautics and Space Administration and the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division. For space probe projects STL provides the total concept approach, including preliminary analysis, sub-system development, design, fabrication, testing, launch operations and data evaluation. The total task requires subtle original analysis in many fields as well as sound technical management.

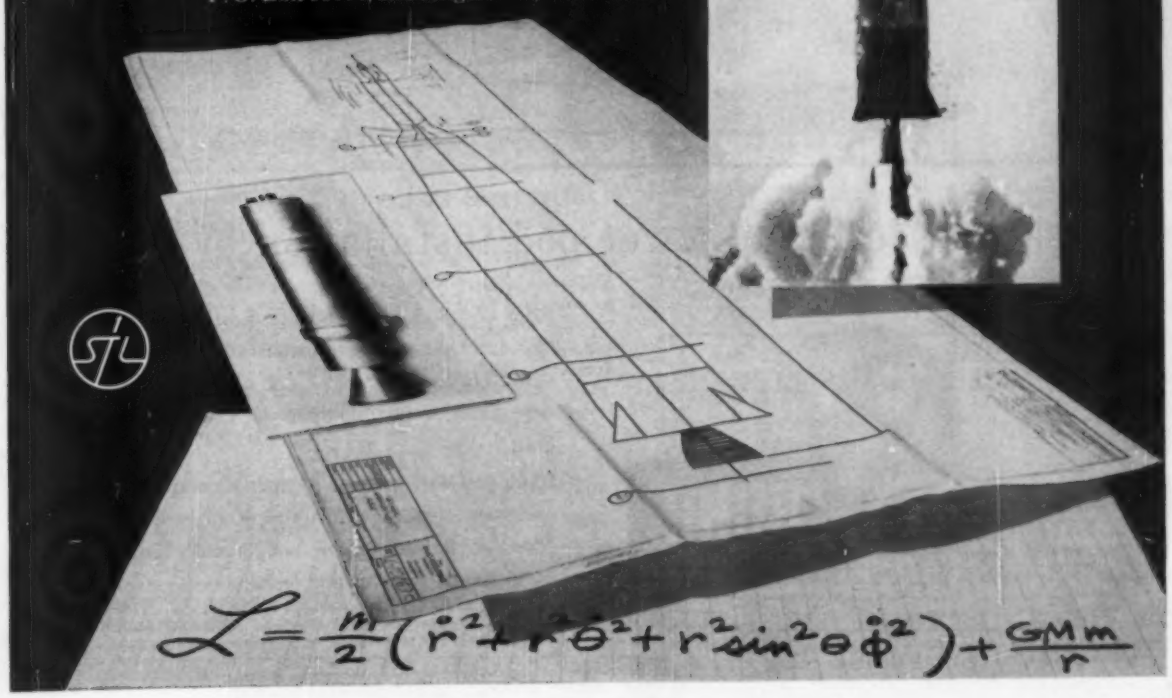
The STL technical staff brings to this space research the talents which have provided system engineering and technical direction since 1954 to the Air Force Ballistic Missile Program. Major missile systems currently in this program are Atlas, Titan, Thor and Minuteman.

The scope of STL's responsibilities offers creative engineers, physicists and mathematicians unusual opportunities to see their ideas tested in working hardware. Inquiries are invited regarding staff openings in the areas of Advanced Systems Analysis, Rocket Propulsion, Space Flight Mechanics, Dynamics, Structural Analysis, and Aerodynamics.

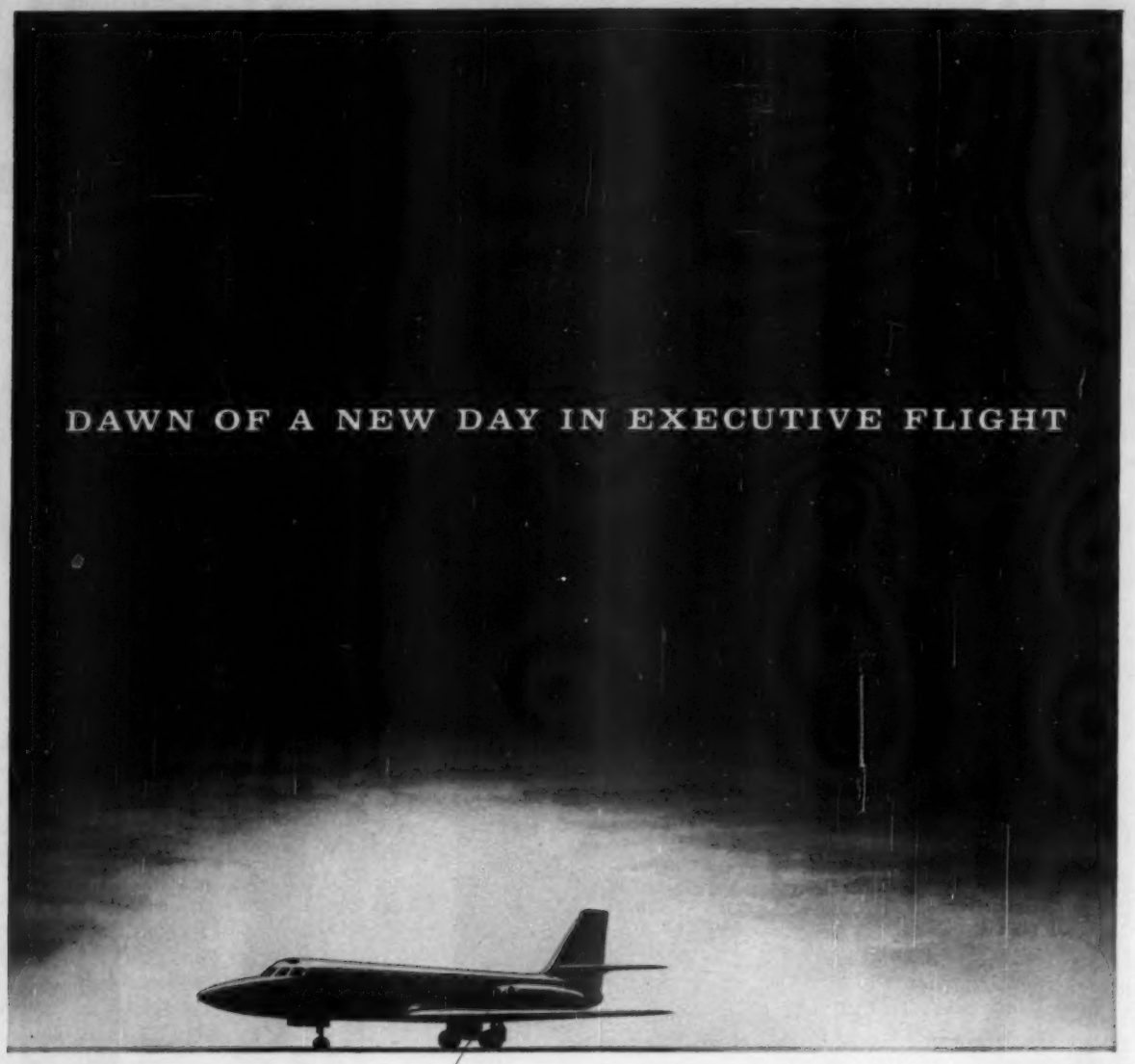


Space Technology Laboratories, Inc.

P. O. Box 95004, Los Angeles 45, California



$$\mathcal{L} = \frac{m}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2 + r^2\sin^2\theta\,\dot{\phi}^2\right) + \frac{GMm}{r}$$



Lockheed JetStar power pod installation by Rohr

ROHR
AIRCRAFT CORPORATION

World's Largest Producer
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Rohr knowledge and know-how are being built into complete, ready-to-install jet pods for the new Lockheed JetStar — one of the first of a new series of fast, compact jet executive aircraft.

Equipped with extensive experience and very special machines and facilities, Rohr is responsible for the engineering and manufacture of these complex power pod installations.

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"Aeroquip rod" inner tube of heavy gauge extruded TEFLON.
Inner layer of braided stainless steel wire.
Reinforcement of multiple plies of spirally wound stainless steel wire.
Outer cover of braided stainless steel wire.
New! Segmented Fitting*
They're leakproof, blow-off proof! Foolproof hose lines are quickly and easily assembled.
*Patent Applied For

BURST PRESSURE

24,000 psi.!

OPERATING PRESSURE: 6000 psi.

AEROQUIP ANNOUNCES VERY HIGH PRESSURE 678 PNEUMATIC HOSE LINES OF TEFLON

Aeroquip makes a major contribution to safety in the handling of very high pressure air, helium, nitrogen and other gases for missile charging systems. Newly developed and now available is rugged 678 Hose of TEFLON, rated for 6000 psi. service . . . *with a 4-to-1 safety factor!*

With an inner tube of TEFLON, which has zero moisture absorption and an anti-adhesive surface, Aeroquip 678 Hose allows fast, easy purging and dehydration. The hose has superior resistance to vibration, low volumetric expansion and high temperature resistance. Return the coupon for complete information.

Aeroquip 678 Pneumatic Hose of Teflon . . .		
Hose part number	678-6	678-8
Hose size I.D.	.312	.437
Hose size O.D.	.609	.812
Oper. press., psi.	6,000	6,000
Burst press., psi.	24,000	24,000
Bend radius at pressure	5	10

All dimensions in inches

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AW-7

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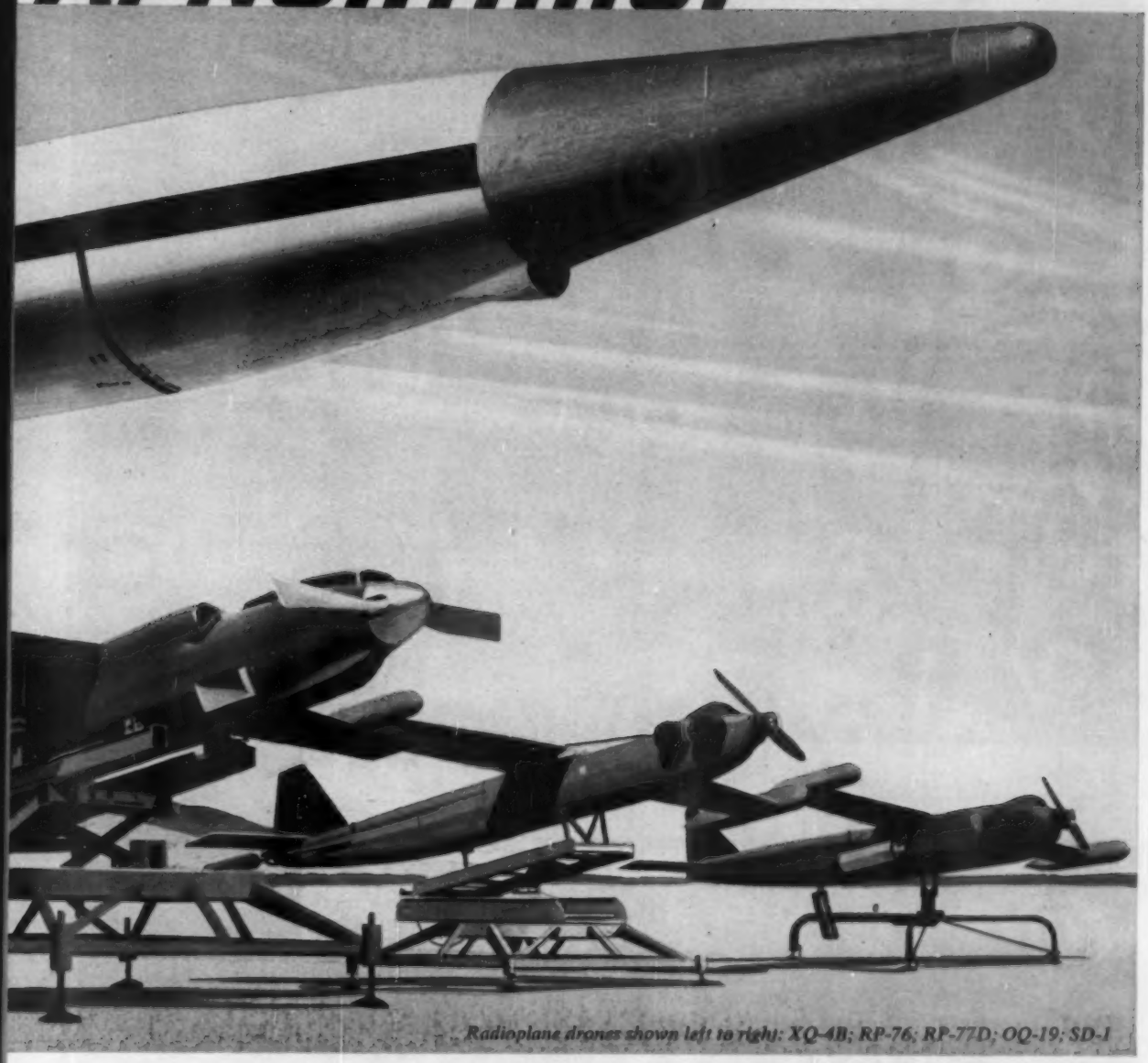
NEWS IS HAPPENING

RADIOPLANE CREATES FIRST FAMILY OF UNMANNED AIRCRAFT TO TRAIN

Radioplane is the world's leading producer of drones and space age recovery systems. As live targets, drones perform as aircraft—then can be recovered by parachute. As evaluators, drones simulate the appearance of the enemy threat while they score our weapon systems' effectiveness. On surveillance missions, drones are zero-length launched, fly cameras, take photos, and return with information within minutes.

Typical of the high-performing Radioplane targets is the RP-76. This smallest target yet fired upon by missilemen is rocket powered, and it has the radar appearance of a large aircraft.

AT NORTHROP



Radioplane drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1

MEN, EVALUATE WEAPON SYSTEMS, AND SURVEY ENEMY TERRITORY!

United States Army requirements for a surface-to-air missile target called for Mach .85 to .89 performance at 40,000 feet altitude. After air launch, the proposed target missile was to have a powered flight duration of eight to nine minutes.

Under the direction of U.S. Army Ordnance, Radioplane produced the RP-76 target missile which has met or exceeded all of the performance specifications. Performance of the complete RP-76 system, including flight operations, is particularly impressive in view of the anticipated low production and operational cost.

Radioplane's leadership in the field typifies the years-ahead thinking that continues to produce design concepts for tomorrow, hardware for today – developed, produced, and delivered on time – at minimum cost to the taxpayer.

RADIOPLANE

Van Nuys, California, and El Paso, Texas

A Division of **NORTHROP CORPORATION**

WESTERN GEAR CAN SUPPLY THE SOLUTIONS

To insure the reliability of the missile, its positioning must be accurately and cautiously handled. No matter what mode of transportation, truck, rail, air or water, there are Western Gear precision drives and related equipment engaged in the touchy and delicate task of handling the mighty "birds." Moreover, Western Gear's extensive experience and facilities enable the company to effectively handle your system requirements.

For complete information on our capabilities and facilities, write on your letterhead for Bulletin 5900.

WESTERN GEAR CORPORATION
Precision Products Division, P.O. Box 192, Lynwood, California

6921

Sharp new eye for navigation

SHARPEST new "eye" for flight is the Ryan C-W Doppler navigator. Based on the advanced development of continuous-wave radar, this system of electronics "intelligence" has been pioneered by Ryan and the U.S. Navy for navigation at all speeds. It tells pilots how to fly to any spot on the globe, with speed and precision, and lets them know exactly where they are at all times.

With the Ryan navigator, military aircraft and jetliners can fly a new "electronic skyway" which provides precise separation between planes and conserves time and fuel. And, because RYANAV systems work right down to ground and sea levels, these advantages accrue at take-off, climb-out, descent and landings, as well as enroute.

The Navy has selected RYANAV for installation in six major types of naval aircraft. They are already in squadron use in the Navy's first all-weather anti-submarine helicopters and are being installed in Army aircraft and helicopters, for low-level "nap of the earth" operations.

Reasons for such wide and versatile use are found in the unique features of RYANAV systems: They are the lightest, simplest, most reliable, most compact of their type. They are setting new standards of accuracy, freedom from adjustment, and ease of maintenance... opening new areas of navigational, guidance, and orientation applications. Ryan electronics engineering assistance is available upon request, to those who wish to explore these areas.

Ryan's rapid growth in electronics is creating new opportunities for engineers and technicians

RYAN BUILDS BETTER

NOW..

HIGH PRESSURE HOSE FOR AIRCRAFT AND MISSILES

STRATOFLEX

SUPER "T-HP" Teflon* HOSE

with medium pressure "SUPER-T" RELIABILITY

Withstands tests more severe than MIL-H-8788

- High Temperature Spectrum tests exceed MIL-H-8788 in both impulse and temperature requirements and fully qualified to ARP 604.
- Positive lock fitting through elimination of socket hex.
- Available with swivel elbows that can be rotated without disturbing the wire grip lock.
- Stratoflex High Pressure Fitting combines the exclusive Pressure Activated Gland Seal and the assurance of crimp design.
- Shelf life practically unlimited.
- Available in two styles of high temperature fittings. Combination of stainless steel and carbon steel, or corrosion resistant all stainless steel fittings.

Hose assemblies are factory assembled from stock with straight, 45° and 90° fittings. Other angles or connections are made to your specifications. WRITE FOR BULLETIN S-7 TODAY!

*Teflon is a registered DuPont trademark

SF7-9

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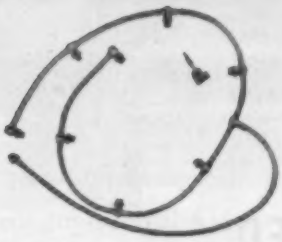
Cable assemblies by BENDIX

Specialized designs for the most exacting requirements

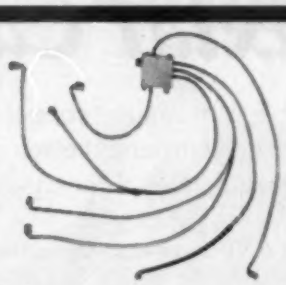
The versatility of design and reliability of performance offered by Bendix* Cable Assemblies result from over a quarter century of precision manufacturing in this field. Our outstanding research and design facilities are available for custom designing cable assemblies to meet your specialized requirements on each installation. Cable assemblies shown are typical Scintilla Division developments in cabling for aircraft, electronic and missile applications.

*REG. U. S. PAT. OFF.

MISSILE CONTROL CABLE: This cable is fabricated using both Benseal® (a plastic molded covering) and Bendix electrical connectors. Protects vital circuitry controlling the firing of missiles.



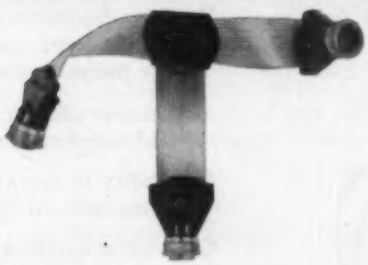
THERMOCOUPLE HARNESS: Flexible, completely sealed and suitable for continuous operation in ambient temperatures of —65°F to 1500°F. Thermocouples are singly detachable and the sealed harness eliminates any chance of trouble from altitude, moisture or other contaminants.



CONTROL HARNESS: This configuration, encased and sealed in metal braid and complete with junction box, can safely withstand the adverse effects of engine environment such as heat, vibration, and oils.

FUEL CELL CABLE: Safely conducts electricity to fuel control valves, pumps, switches and gaging devices immersed within fuel cells. Features: unbroken stainless steel bellows type conduit, double layer protection between current carrying conductors, stainless steel integral connector shells.

HEAVY DUTY CABLE: Ground support cable assembly built and designed for hard usage at missile launching sites. Heavy duty moldings and a tough neoprene tubing combine to resist wear.



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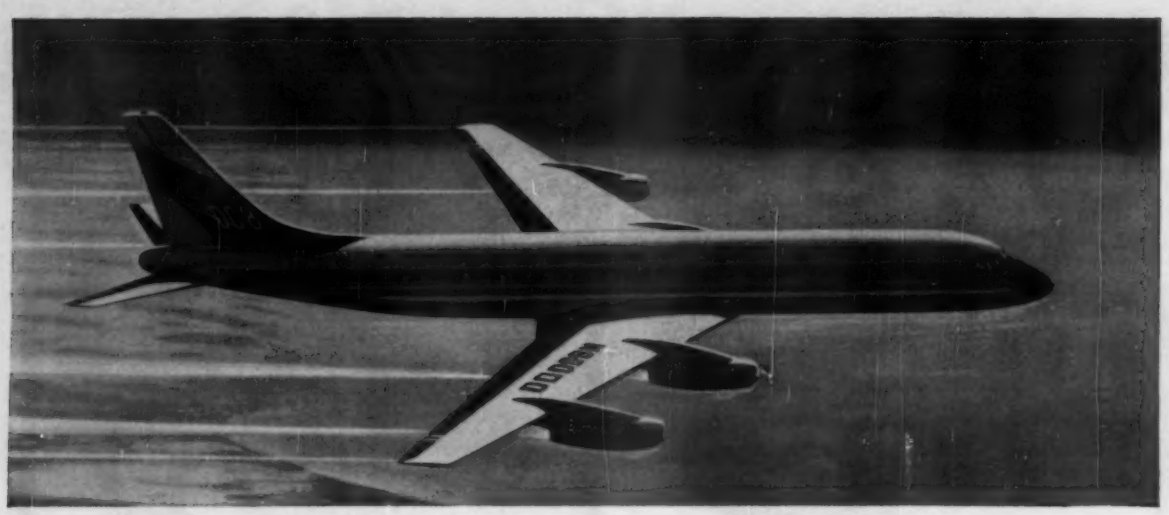

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4. Greater efficiency and improved system performance without the use of additional electronic components.
5. Ability to operate in both pressurized and non-pressurized parts of a plane without the use of cable dehydrators or pressurizing systems.
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The old Pitcairn "Mailwing" was equipped with the "Model B" radio range receiver

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The instrument sought was known as the "Model B", designed in 1927 and sold by the company as early as 1928.

The equipment was used in the old Pitcairn "Mailwing" model aircraft, used by N.A.T., which later became United Air Lines. It was also used on Colonial between Boston and New York. In 1929 it served Admiral Byrd's first expedition to the South Pole

The Smithsonian considers this instrument of significance in depicting the history of aviation and electronics.
If you have a "Model B", or know where one can be found, it will be worth your while to communicate with

Aircraft Radio Corporation

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ALCOA ALUMINUM

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July 27, 1959

Aviation Week

Including Space Technology

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COVER: First picture of thrust chamber for first U. S. liquid hydrogen rocket engine, the 15,000-lb. thrust Pratt & Whitney XLR 115-P-1, shows it being hoisted into test stand at P&W's Florida Research and Development Center. Chambers have been firing since early spring. Two gimbaled XLR 115s will power Convair Centaur upper stage for Air Force, National Aeronautics and Space Administration and Advanced Research Projects Agency missions. High expansion ratio (approximately 40) of nozzle is typical of high altitude engines. Sloping shed of roof increases safety by allowing rapid rise of hydrogen gas in case liquid hydrogen spills and boils off. For other pictures and story, see p. 28.

PICTURE CREDITS

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EDITORIAL

Possibilities for Gross Error

As the Berlin crisis festers like a boil, growing more tender and closer to eruption with the passing of each fruitless week in Geneva, the possibilities of a nuclear war through major miscalculation becomes more likely. We know that the United States will not take the first step in precipitating nuclear war, and we seriously doubt whether the leaders of the Soviet Union would deliberately take this action at this time if they were fully aware of its consequences. The great danger lies not in the realities of the current military equation between the United States and its allies balanced against the Soviet Union and its Communist satellites but rather in a major miscalculation of this equation by Nikita Khrushchev and his advisers.

It is difficult for people who have not visited the Soviet Union to understand how thoroughly the Iron Curtain cuts off almost all realistic information about the rest of the world from the Russian people, including many of their leaders, and how strongly the information allowed to penetrate is focused toward the Soviet viewpoint. This focus makes it impossible for the Soviet citizen to get much realistic perspective on his position in the world. Any American visitor to the USSR who has attempted to discuss the most simple facts of life in this country with Soviet citizens quickly runs into this mental block. The rigid restrictions on travel of Soviet citizens in non-Communist countries and the restriction of Russian travel in the U.S. to carefully-screened, official delegations is part of this determined, almost pathologic effort to prevent any element of reality regarding the rest of the world from penetrating to the Soviet population. At the same time, there is a tremendous thirst for knowledge of the outside world on the part of the Soviet citizen, at all levels, as the visiting American will soon discover once he breaks through the officially erected barriers.

With a consistently and deliberately distorted view of almost everything foreign beamed at the Soviet mind, it is hard to prevent even the highest levels of government from becoming partial victims of their own propaganda. And this is where the real danger lies in the Berlin crisis and those that will inevitably follow.

Because of this international astigmatism, it is difficult for the Soviets to realistically appraise either the military strength of this nation or its determination to use it when necessary. History has recorded this same miscalculation by the Germans twice and by the Japanese with the disastrous results therefrom also a matter of historical record. It is, of course, an occupational disease of a power-hungry dictator that he always is sure he will avoid the mistakes made by his downfallen predecessors. But history has yet to record one who really did.

It is apparent from Nikita Khrushchev's increasingly blatant boasting of Soviet military might that he is leaning dangerously toward such a fundamental miscalculation that might make a nuclear war now appear to be an attractive exchange. As Gen. Thomas Power, chief of Strategic Air Command, emphasized so sharply to Congress last spring (AW April 13, p. 21), it is really Mr. Khrushchev who is the vital judge of the United States' strategic deterrent capability—not the U.S. Joint Chiefs, Gen. Power, the Congress or the President. Only Mr. Khrushchev knows what will deter him at any given moment and his standards of disaster are far different from those in this country. Mr. Khrushchev is reported to have told Averell Harriman recently that he was prepared to lose Leningrad in a nuclear exchange with the West and indicated he thought that would be the extent of the Soviet damage. If this is true somebody had better get across to Mr. Khrushchev a more realistic appraisal of the current SAC nuclear delivery capability.

Here are some of the misconceptions that appear to roost in Russia as a result of their rigid control and official distortion of information from the Western world:

• **The heated and often acrimonious debate over our defense program** is interpreted in Russia as an argument over whether we will support a defense program or not. They apparently do not realize that the country is firmly united on this point and the debate concerns only the pace and scope of the defense program. They overlook the fact that we are pouring about $40 billion a year into defense and the debate concerns only whether we should add from one to four billion.

• **They appear to believe that the business and financial community** is the Achilles Heel of the U.S. defense position and that the twin lures of lowered taxes due to a "peace offensive" that will reduce defense expenditures and big profits from trade with the Soviet bloc will prove irresistible to U. S. business and finance.

• **They have misinterpreted the inexcusable political, executive and administrative bungling** in our defense program as a lack of genuine technical and industrial ability in the critical new fields of weapons technology such as missiles and space. As a result, they tend to overestimate the magnitude and possible duration of their unquestionable lead in certain phases of these fields.

• **The tremendous promotion of their genuine scientific successes** and the suppression of all failures viewed against our policy of discussing success and failure with almost equal candor tends to give the Soviet citizen and official —outside the technical circles who know better—a violently distorted picture of their nation's capability relative to the rest of the world. Very little reaches the Soviet citizen about the genuine progress in weapons technology achieved in this country.

• **Because we often fail to back our "no retreat" top-level policy statements** with what would be interpreted in Russia as effective military preparations, the Soviets believe we don't mean what we say and are really preparing to retreat or compromise. The Soviet's public charge of "sabre-rattling" if these preparations were made would be a small price to pay for their actual effect on Soviet policy-making.

There is no doubt that the Soviet military position has improved substantially in the past five years and the once unchallenged Western margin of superiority has diminished. There also is a great danger that if we fail to accelerate and expand our weapons development programs into the new technologies we will face a position of critical inferiority in the future.

But the greatest danger today and for the immediate future is the possibility of war based on a major miscalculation by the Soviet leaders of our military capability and our determination to use it when necessary.

—Robert Hotz

From the Ford Trimotor in 1929 to the Boeing 707 jet of today, Kidde nacelle fire extinguishing systems have set the standard for the aviation industry. For thirty years Kidde has always been ready with lighter weight, more efficient equipment to meet the fire safety needs of ever faster and more complex military, commercial, and private airplanes. Actually since 1929, Kidde has supplied nacelle systems for 272 different models, built by more than 30 airframe manufacturers! At this very moment Kidde is developing still lighter weight, faster operating systems using new, more efficient fire extinguishing agents.

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WHO'S WHERE

In the Front Office

Edward G. Uhl, vice president-technical administration, Ryan Aeronautical Co. Mr. Uhl was formerly vice president of the Martin Co. and general manager of Martin's Missile Division, Orlando, Fla.

M. Carl Haddon, a vice president, Lockheed Aircraft Corp., and general manager of the Electronics and Avionics Division, Los Angeles, Calif., succeeding the late Louis N. Ridenour.

John C. McGregor, a director, North Atlantic Industries, Inc., Westbury, N. Y. Mr. McGregor is board chairman and president of Narda Microwave Corp. and Narda Ultrasonics Corp.

John L. Heasley, president, California Duplicating Co., Inc., Burbank, Calif. Also: **Bernard Entin**, secretary-treasurer; **Harry W. Godley**, assistant to the president.

Charles L. Jones, executive vice president, American Electronics, Inc., Los Angeles, Calif.

Russell A. Kimes, a divisional vice president, American Machine & Foundry Co.'s Government Products Group. Mr. Kimes continues as director of AMF's General Engineering Laboratories, Greenwich, Conn.

William T. Marx, senior vice president-planning, organization and industrial relations, International Telephone and Telegraph Corp., New York, N. Y. Also: **Harry G. Beggs**, vice president-manufacturing and facilities.

Hughes Aircraft Co., Culver City, Calif., has announced the following appointments: **John H. Richardson**, director of marketing; **Clarence A. Shoop**, manager, International Division (Mr. Shoop continues as vice president and director of product reliability and flight test); **David A. Hill**, manager, Hughes' Santa Barbara, Calif., Research Center; **John L. Winkel**, manager of the company's Washington, D. C., office.

Kenneth H. Bender, divisional comptroller, AC Spark Plug Division of General Motors, Flint, Mich.

Honors and Elections

Gen. I. A. Aler, president of KLM Royal Dutch Airlines, has been elected chairman of the Industry Advisory Committee, Flight Safety Foundation, Inc., New York, N. Y.

Dr. Clarence Zener, director of the Westinghouse Electric Corp. research laboratories, has been elected to membership in the National Academy of Sciences for "distinguished and continued achievements in original research."

Eugene McDermott, supervisor of packaging and packing for General Electric's Heavy Military Electronics Department, has been named chairman of the Preservation and Packaging Committee of the Aerospace Industries Assn., Washington, D. C.

Herbert H. Munsey, general manager of Republic Aviation's Helicopter Division, has been made a Knight in The Order of Merit of the Republic of Italy for "his contributions to widening the activity of Italy's aircraft industry."

(*Continued on page 99*)

INDUSTRY OBSERVER

► Proposals for guidance and control system for Air Force's new air-launched ballistic missile, WS-138A, were due last week from avionics manufacturers. Douglas Aircraft Co., as the ALBM prime contractor, will evaluate proposals, then recommend its choice of avionics manufacturer for final Air Force approval.

► **Thiokol Castor rocket used in National Aeronautics and Space Administration's Little Joe test vehicle (AW July 13, p. 31) differs from Thiokol Sergeant in that nozzles are slanted outward and expanded slightly to give better performance at altitude at sacrifice of weight; case and brackets differ; propellants are slightly different chemically. Castor is roughly the same weight, diameter, length and performance as Sergeant.**

► Douglas El Segundo Division has a Navy development contract for a unique detection system under research by the company for some time designed to permit the effective use of its A4D Skyhawk and other relatively small aircraft in anti-submarine warfare work.

► **Navy hopes Air Force will place an order for the Grumman A2F "slow" attack plane designed to Navy specifications to fly at speeds of Mach .9 at sea level for use by USAF's Tactical Air Command. Air Force order for the aircraft designed to escape radar detection by sticking close to the ground would cut unit costs, permit the Navy to receive more aircraft with the funds it has slated for the program.**

► Pressure in the pure oxygen atmosphere of the Project Mercury capsule will be 5 psi.—equivalent to the pressure at about 27,000 ft. altitude. Pilot goes on oxygen when he is put into the capsule about an hour before launch and keeps the face plate of his pressure suit closed. Plate can remain open during orbital flight but is closed again for re-entry phase. Air is cooled by a water boiler and refrigeration cycle. Suit and capsule are a common environmental system, but the suit also has its own emergency capability.

► **Mercury capsule recovery aid systems are being tested by dropping capsule models at sea off Norfolk, Cape Canaveral and Mayport, Fla. They are recovered by the same Navy units which will do the actual recovery job when the Mercury capsule returns from orbit.**

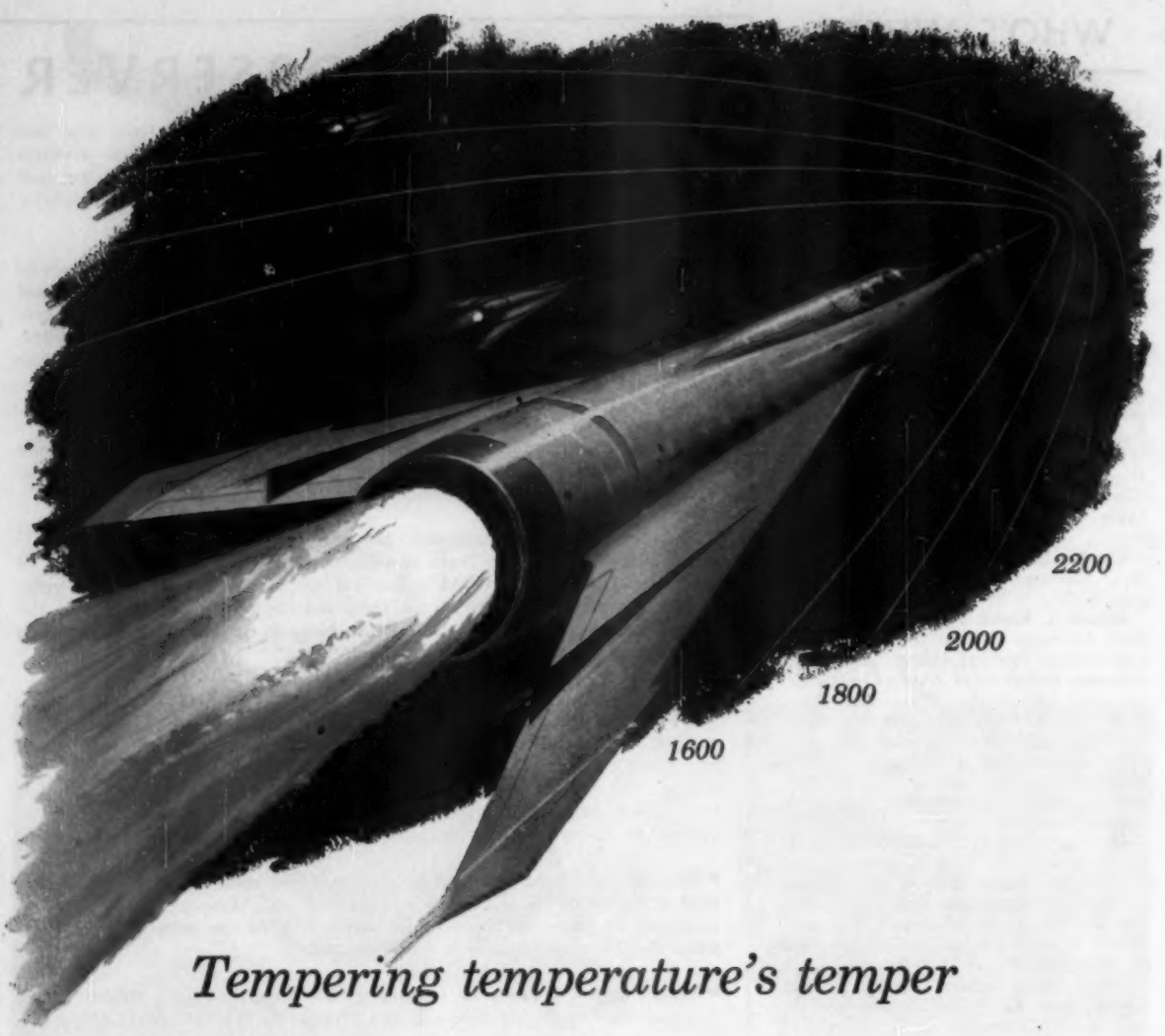
► Massachusetts Institute of Technology has a contract for a stability study in connection with Air Research and Development Command's WS-117L advanced reconnaissance system.

► **Fracture of a jetavator ring on one of four first-stage exhaust nozzles caused failure of the Navy-Lockheed Polaris AX-11 test vehicle in flight (AW July 20, p. 28). Shock of initial acceleration broke off a small piece of one jetavator ring. Vehicle managed to program over into trajectory but was not able to maintain course after a wind shear deflected it. Missile was destroyed by ground control shortly after ignition of second stage.**

► Honeycomb sandwich structure using 0.002 in. thick molybdenum foil for core between the molybdenum face sheets with a new type protective coating has successfully withstood 2,000F for periods up to one hour without any breakdown in coating. Sandwich was built and tested by the Norair Division of Northrop Corp.

► **Bids will be opened this week in the award of contracts for construction of shelters and launch facilities for the Air Force-Boeing Bomarc IM-99 ground-to-air interceptor missiles to be based at Strategic Air Command's Vandenberg AFB, Calif.**

► Fairchild M-24 vectored slipstream STOL flying testbed for the Army has been completed and is now undergoing final checkout and instrumentation prior to the beginning of outdoor ground testing at the company's Hagerstown, Md., plant next month. Control system features small coaxial rotors atop the horizontal tail that can be tilted and rotated at different speeds.



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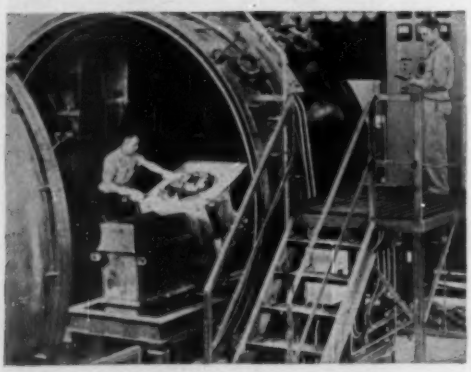

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Washington Roundup

Keirn Boosts Nuclear Plane

U. S. could put a nuclear-powered testbed aircraft into the air in four years if the necessary funds were made available now, Maj. Gen. Donald J. Keirn, chief of the Air Force-AEC nuclear aircraft program, said last week in his strongest statement thus far in support of the "fly early" development concept for the atomic plane.

Keirn's position, laid out in testimony at hearings of a subcommittee of the Joint Congressional Committee on Atomic Energy, is in direct contrast to the Administration's "go-slow" policy of flying a nuclear aircraft only after its engines can exceed the performance of chemically fueled turbojets advocated by Dr. James Killian who recently resigned as the President's scientific adviser. Major points made by Gen. Keirn include:

• **Main objective of the Air Force** is to develop a direct cycle nuclear propulsion system similar to the one under development by General Electric Co. Keirn's office does not want to wait for the availability of "full performance cores" and believes a flying testbed using the existing reduced temperatures cores will expedite development of a useful weapon system.

• **Preliminary design studies** of indirect cycle nuclear powerplants, under development by Pratt & Whitney Division of United Aircraft Corp. and now under Navy cognizance, have shown that there is a possibility of achieving the necessary thrust-to-weight ratios for high altitude, supersonic speed flight on nuclear power alone. This engine is not as advanced as the direct cycle engine, and no time schedule could be attached to its development. It is considered promising, however, for the construction of a nuclear powered aircraft of the B-70 type.

• **Agreement was reached in 1955** between Keirn and Adm. James S. Russell, then chief of the Bureau of Aeronautics, that Navy participation in the nuclear aircraft program would not "generate into competition" to fly first. The Navy requirements for an atomic-engined seaplane, he said, is best met at present through the use of the indirect cycle engine and a unit type shield which is heavier than that required by the Air Force but protects all of the aircraft's equipment and personnel from radiation.

• **Air Force procedure for establishing** weapon and equipment requirements has changed during the last six months. Formerly, the nuclear powered strategic system was justified under General Operational Requirement No. 81. The program to meet this requirement was Weapon System WS-125A. Now the planning echelons of the Air Force are in the process of replacing General Operational Requirements with either Specific Opetational Requirements or System Development Requirements. The specific requirements are required to meet "near-term" needs of the Air Force for weapon systems, are considered compatible with the state-of-the-art, and a production program is contemplated.

Gen. Keirn believes that the nuclear aircraft program now falls under the other category, System Development Requirements, which describes in "general terms the characteristics of a new system required for the attainment of a forecast operational capability requirement presently beyond the technical state-of-the-art."

Keirn also reiterated his charge of last fall that the present lagging position of the U. S. nuclear aircraft program is the responsibility of top Administration officials (AW Nov. 24, p. 27). He said: "You will note that there has been a fluctuation in flight testing philosophy brought about by decisions at the Department of Defense level, but there has been no change in the technical direction of approach of the propulsion system."

Procurement Policy Review

Major review of defense procurement policy authorized in the law extending renegotiation (AW July 6 p. 28) will be carried on separately by House and Senate Armed Services Subcommittees. The Senate group, named last week, is headed by Sen. Strom Thurmond (D.-S. C.), and includes: Sen. Clair Engle (D.-Calif.), Sen. Howard Cannon (D.-Nev.), Sen. Leverett Saltonstall (R.-Mass.) and Sen. Prescott Bush (R.-Conn.). The House group (AW July 20 p. 28) is headed by Rep. Carl Vinson (D.-Ga.) who has led congressional opposition to incentive type contracts extensively used in aircraft and missile procurement.

GAO vs. Saltonstall

General Accounting Office is putting up formidable opposition to the proposal of Sen. Leverett Saltonstall (R.-Mass.) to cut lead time on advanced weapons by turning over more authority to a single prime contractor and encouraging incentive-type contracts. GAO said in a report to Congress:

• **A single weapons prime** contractor could attain "so dominant a position with respect to a vital weapon system, and the military department lose such control, that it becomes almost completely dependent, as a practical matter, upon the contractor. This could seriously impair the military department's ability to discharge its basic military mission."

• **Encouragement of incentive** type contracts would "increase the incentive to higher profits and make price negotiation more difficult, but we see no assurance that it would create an incentive to contractors to be efficient or low-cost producers."

GAO called for "effective competition" through design, research, and development, as well as production stages, of weapon systems contracts. This, GAO maintained, would do more to cut lead-time, as well as costs, and advance the state of the art than the Saltonstall proposal.

707 to Moscow

Pan American's first Boeing 707-321 intercontinental turbojet last week flew 95 passengers and crew members nonstop New York-Moscow in 8 hr. 45 min. As compared with a previous record of 9 hr. 48 min. set 10 days earlier by the Russian Tu-114 turboprop transport (AW July 13, p. 37). The U. S. turbojet was originally scheduled to carry Vice President Nixon and his party plus 40 members of the press to Moscow for the official Russian visit but a last minute jump in the size of both the official and press parties forced the use of two aircraft. Since Nixon's party was the smaller—38 as compared with an original group of 10—it flew from Baltimore to Moscow with a refueling stop at Reykjavik, Iceland, in a Military Air Transport Service VC-137—military designation for the Boeing 707-120.

—Washington staff

Navy Bids to Capture Major Space Role

Three-service 'military space command' proposed; plan may touch off new Defense Department row.

By Craig Lewis

Washington—Navy is making a bold bid for a major share in U. S. military space programs with a proposal for a joint military command to run space operations.

Under the Navy proposal, a Military Space Command would be established to run space system operations, with the individual systems assigned equally among the three services for actual operation. This would assure the Navy and Army an equal share with the Air Force in the military space program. The organization would be run on a rotational basis, with each service taking its turn in command.

The plan is currently only a proposal under study on the Joint Chiefs of Staff level, but it indicates a strong Navy campaign for a major share in space programs, and it may be one of the opening guns in a new phase of the interservice power struggle which periodically flares up in the Department of Defense.

Pressures Mount

With Navy and Army functions increasingly confined to the limited warfare area, internal pressures are mounting for a means of giving the two services significant roles in the space field which is increasingly dominated by the Air Force. The Navy proposal would accomplish that, and the Army and Navy have a potent weapon in their two-one voting edge over USAF in the Joint Chiefs of Staff.

Navy has been trying for several months to organize its own space effort into a single, integrated program, but final arrangement has not been announced because of an unresolved controversy over whether the program should be run by the Deputy Chief of Naval Operations for Air or the DCNO for Development.

Another proposal to the Joint Chiefs of Staff concerning operation of the Navy's Polaris fleet ballistic missile undoubtedly is a factor in the service's push for a space role. This proposal would place Polaris missile under command of the Strategic Air Command, taking away the Navy's only advanced strategic weapon. The fight over Polaris and the controversy bound to arise over the Navy space command concept could erupt into another battle reminiscent of the basic roles-and-missions struggles involved in the Thor-Jupiter and Nike-Bomarc controversies.

In broad outline, the proposed Military Space Command would have a commander and a vice commander, with the duties rotated among the three services. It would have deputies from the three services, plus a deputy from the National Aeronautics and Space Administration. The command also would have a scientific adviser.

The agency would fit into the Defense Department organization under direct command of the Joint Chiefs of Staff as are the various unified commands and SAC. It would differ from the other joint commands, however, in its rotation of command. This would, Navy contends, bar dominance of any one service.

Staff Organization

Staff organization of the space command would include such elements as support, administration, operations, communications, logistics and plans, programs and policy. Major elements of the operational organization would include launch, support and tracking, readout and communications. Under this line setup would come the Pacific Missile Range, Atlantic Missile Range, White Sands Missile Range, a tracking and surveillance coordination center and additional forces and facilities which might be assigned to the command.

Each of the missile ranges is currently under command of one of the three services. The tracking and surveillance coordination center would be jointly manned and would include groups for detection and tracking, communications, operations, computation, administration and planning.

Presumably, the Military Space Command would take over the job of operating space weapon systems when the Advanced Research Projects Agency and other organizations had finished development work on them. The command's sphere probably would include such systems as reconnaissance satellites, weather satellites, communication satellites and anti-missile warning and control satellites.

Navy arguments backing the space command proposal indicate the interest of a broad spectrum of military organizations in the various orbital systems. These groups, Navy says, range from Strategic Air Command to carrier strike forces and Army strike forces, although the intensity of interest varies as widely among the systems as the functions of the organizations using them.

Another argument is that the joint space command would assure the U. S. of early exploitation of space exploration prospects.

Elimination of facility duplication is a factor cited in the Navy arguments, along with the contention that a joint operation would ensure that all personnel are properly indoctrinated. Evolution of orderly operational requirements and clear definition of military

Navy ANP Contract to Martin

Washington—Navy's Bureau of Aeronautics is awarding the Martin Co. a $127,000 contract for the study of airframe designs for a nuclear-powered turboprop anti-submarine seaplane. Funds will come from approximately $2 million scheduled to be spent by the Navy on the nuclear powered ASW seaplane during Fiscal 1960.

The major portion of these funds will go to Pratt & Whitney Division of United Aircraft Corp. for the further development of an indirect cycle reactor system using liquid metal as a heat transfer medium and with a heavy shield located completely around the reactor to protect both the aircraft equipment and crew from radiation. Pratt & Whitney also has the responsibility of matching a turboprop engine to this reactor system.

Navy philosophy of developing a workable engine before proceeding with elaborate system and airframe design work has been outlined to the Congress by Vice Adm. John T. Hayward, deputy chief of naval operations for development. This procedure with the atomic-powered seaplane follows the pattern set by Vice Adm. H. G. Rickover in the development of nuclear submarines. Hayward expects that the nuclear seaplane will fly by 1964.

Martin has received a total of $100.5 million for nuclear seaplane design studies since 1953, but the new contract for $127,000 is the most specific in terms of the aircraft desired and engine to be available.

space operations are cited as further advantages.

With the proposal in an early stage of consideration, it is difficult to determine what the space command's relationship would be with currently operating organizations. There is considerable military dissatisfaction with the present civilian orientation of the space program NASA is running, and a powerful joint military space command might be moved to acquire some projects from NASA. The presence of an NASA deputy in the proposed version of the Military Space Command's table of organization would seem to indicate at least some coordination between the two groups.

Even within the Defense Department there is some question concerning the extent of space operations the Military Space Command would run. It might be confined to satellite operations or it might extend to intercontinental ballistic missiles which operate largely in space during their ballistic flight. MSC also might get involved in the defense of the continental U. S., since this job is increasingly becoming involved with space operations.

Such enlarged authority could encroach upon the present operational areas of such groups as SAC and North American Air Defense Command and thus create another roles-and-missions controversy. Or practical considerations might dictate that all these global jobs be included in a military space operation that would cover all but local war operations.

The Navy idea of dividing space operations equally among the services under the umbrella of a joint command runs strongly against Air Force philosophy, and some sharp dissents from USAF can be expected in Defense Department councils before anything of the nature of a Military Space Command becomes a reality.

Air Force thinks satellite systems, as well as other systems, should be operated by the service with a primary interest in them rather than arbitrarily parceled out on a sharing basis. Currently, these space systems are handled by their primary users, and USAF would like to see it stay that way. Maintaining the status quo, of course, would maintain Air Force domination of space operations.

Joint space operation also runs against the USAF philosophy that setting an arbitrary border between the atmospheric field of normal Air Force operations and a space area for joint command is nonsense. Air Force believes that space is an area where its own operations will be expanding naturally with technological progress, not a place where an entirely new organization and new operations should be established.

First Drawing Shows Corvus Configuration

Test version of Temco Corvus, Navy's new supersonic air-to-surface guided missile, has been air launched for the first time over Pacific Missile Range's sea test corridor south of Naval Missile Center, Pt. Mugu, Calif. Powered by a rocket engine using prepackaged liquid propellants (AW April 14, 1958, p. 23), Corvus is of a size to be used by carrier-based aircraft and is designed as a stand-off weapon to attack heavily defended areas including surface ships from outside the range of their defenses. First launch was from Navy Douglas A4D Skyhawk. The initial launch phase of the Corvus program was preceded by a comprehensive preflight and serviceability inspection at the Temco plant where a Navy team of some 50 specialists reviewed results of extensive ground tests at Dallas and at Pt. Mugu. Major subcontractors to Temco on Corvus include Reaction Motors Division of Thiokol which developed the prepackaged liquid rocket engine, Texas Instruments, Dallas, Tex., W. L. Maxson Corp., New York City, Williamson Co., Madison, Ind., Horkey-Moore Associates, Torrance, Calif., Douglas Aircraft's Tulsa Division, Avion Division of ACF, Paramus, N. J., Emerson Research Laboratory, Silver Spring, Md., Bulova Research Laboratory, New York, and Talco Engineering, Mesa, Ariz.

Although there has been some discussion of battles being fought in the isolation of space, USAF regards this largely as a possibility of the future and maintains that military problems and operations must still be considered in a terrestrial context. The core of this argument is that the areas to be attacked and defended are on earth and that, while weapon systems may travel through space in their missions, their objectives are earthbound.

Orientation toward the target or mission purpose rather than the means of delivery is the basis of the USAF proposal for SAC operation of Polaris. Navy naturally wants to keep Polaris, and the MSC proposal may provide the impetus for some trading before the final status of the underwater missile is decided.

Proposing a joint space command is a reversal of the traditional Navy stand against the principle of unification, although the type of unification contemplated in MSC would seem to be aimed more at maintaining separate service identities in a new field than at blending the three services into a single working organization.

Engine Malfunction Grounds 540

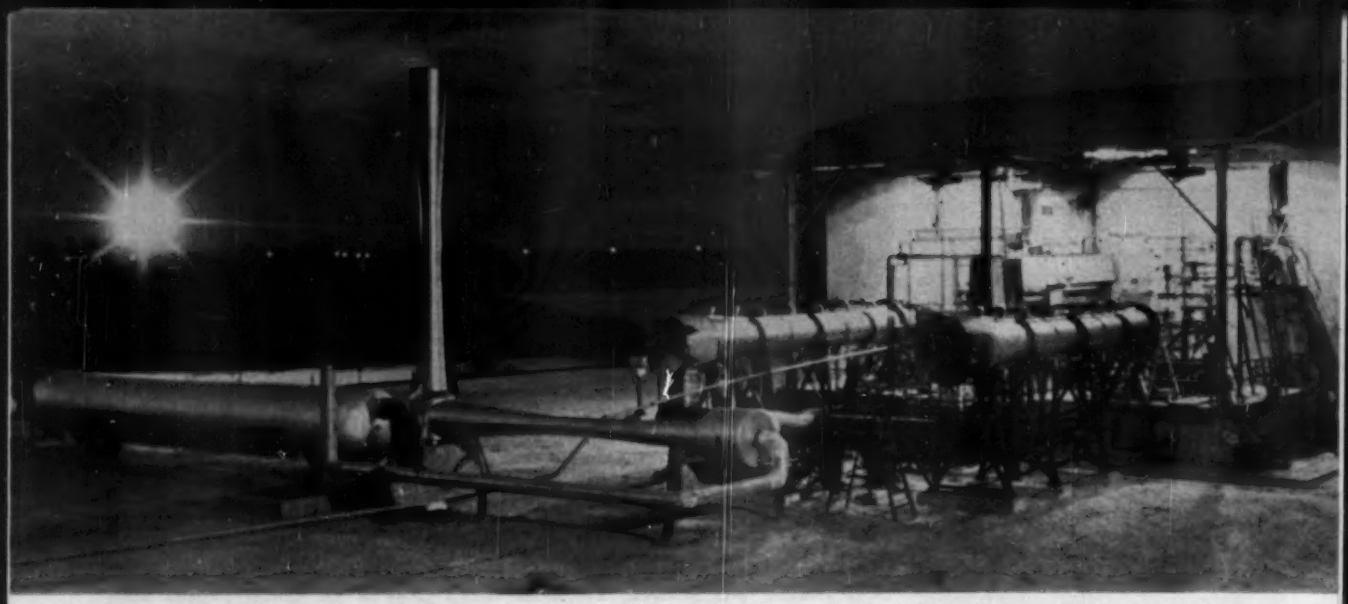
Washington—Allegheny Airlines last week was forced temporarily to withdraw its Canadair 540 turboprop transport from scheduled service because of bearing malfunctions in the Napier Eland engines.

The airline is leasing the airplane from Canadair for a three-month period to determine whether a fleet of the turboprops will be suited to Allegheny's operation. Engine maintenance and overhaul during the term of the lease is being handled by Napier crews.

Cause of the four bearing breakdowns which have interrupted an otherwise good service had not been immediately determined as of late last week. The malfunctions failed to follow a set pattern that might give Napier engineers some clue as to the source of the problem.

Latest bearing breakdown, however, was traced to a dent in the race in the reduction gear area which led Napier officials to believe that the engines were being damaged by truck or road shock during shipments from New York to Washington. Future engine deliveries from England will be handled entirely by air through to Washington. Meanwhile, a full analysis of the bearing problem will be made before the planes are put back into service.

Allegheny began service with the Canadair 540 July 1 with one round trip daily between Washington and Atlantic City and three round trips daily between Atlantic City and Pittsburgh. Utilization of the aircraft averaged eight and one-half hours with all progressive maintenance and overhaul accomplished between 10 p. m. and 6 a. m.



DUAL LIQUID hydrogen rocket engine test stand at Pratt & Whitney West Palm Beach, Fla. facility, with steam ejector system in foreground.

Space Technology

Centaur Space Engine Components Fired in

By Evert Clark

West Palm Beach, Fla.—Thrust chambers for the first U. S. liquid hydrogen rocket engine have been firing here since early spring in the rapid development of a new type powerplant that already is earmarked for a variety of specific military and civilian space missions.

It is not known whether the complete 15,000-lb.-thrust engine, designated XLR 115-P-1, has been tested in the full scale version, but all components have been tested either in full or small-scale firings.

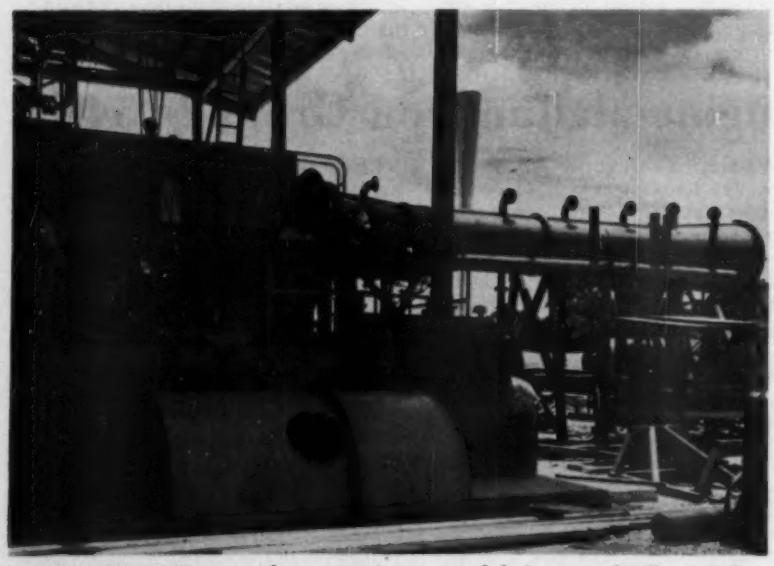
The XLR 115-P-1, including pumps, control valves, nozzles, injector plates, etc., is being developed by Pratt & Whitney Aircraft's Florida Research and Development Center as the first of a family of powerplants that eventually will have thrusts of 300,000 lb. or more.

Two XLR 115 engines will power the Convair Centaur upper stage, which will be used by the Air Force in a communications satellite launching vehicle; by National Aeronautics and Space Administration for satellite, space probe, lunar reconnaissance and man-in-space missions and by Defense Department's Advanced Research Projects Agency and NASA for the Saturn space vehicle.

The importance of liquid hydrogen as a space fuel in the very near future is clearly demonstrated here by the existence of the research center, with its 15 company-financed hydrogen engine and component test stands, and the multi-ton capacity USAF-Air Products, Inc., liquid hydrogen production plant next door.

The four horizontal engine test stands built by Pratt & Whitney are stressed for thrusts of up to 300,000 lb. A larger vertical stand now under construction will accommodate a complete space vehicle. It is being jointly financed by the company and the government. Much higher thrust advanced models of the XLR 115 already have been designed in detail.

Two gimbaled XLR 115s will be used side by side in the Centaur vehicle. This not only permits roll control but allows the stage to be shorter, narrower and lighter than if a single thrust chamber were used.



VACUUM CHAMBER now under construction at second dual test stand will permit firing of complete XLR 115 engine in simulated space conditions. Steam ejector system now used to evacuate diffuser behind nozzle will evacuate chamber.

Centaur Stage

Centaur stage will be 10 ft. in diameter to fit the modified Convair Atlas that will serve as a first stage. Although the Centaur stage will weigh about the same as the Vega liquid oxygen-kerosene upper stage planned for another Atlas-boosted vehicle, it has advantage of about 40% over the conventional

Thrust capacity is 300,000 lb. each.

Test Program

Vega stage because of hydrogen's greater specific impulse.

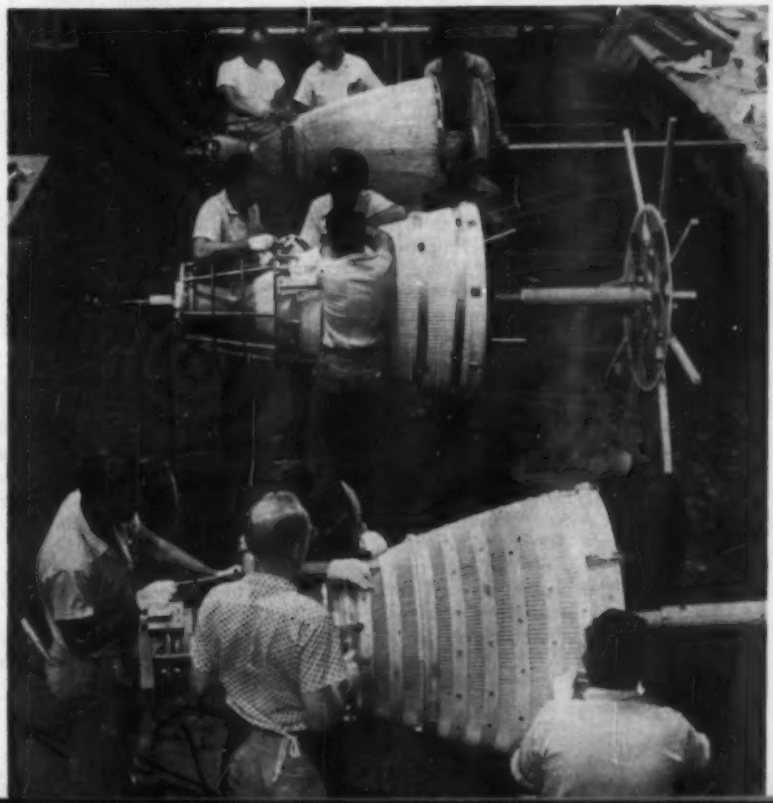
The XLR 115's thrust can be increased beyond 20,000 lb. using essentially the same hardware, Pratt & Whitney says. The engine can be shut down and restarted in space. Since the engine is to be used outside the atmosphere, its nozzle—made of stainless steel tubing and using regenerative cooling—has a very large expansion ratio, which appears to be about 40.

Extremely low temperature of liquid hydrogen (−423F) requires that measurements of lengths of the actuator rods used for gimbaling the XLR 115 engine be made when the engine is very cold. Use of the hydrogen for regenerative cooling of the nozzle means that the nozzle actually shrinks during firing.

Although the engine is a complete flight design and not an assembly of existing parts, its general design and appearance are believed to be quite similar to engines using conventional propellants.

Simulated space conditions for engine testing are created by firing into a convergent-divergent supersonic diffuser which is first evacuated to 0.16 in. of mercury absolute by means of a two-stage steam ejector. Steam is stored as superheated water at 250 psig. and 400F. Steam flow rate is 2,900 lb./min. at 100 psi. Ejector system is fired in bursts on the order of 10 sec. Sequence includes firing of the steam ejector; actuation of the engine's electrical ignition system, which cycles the main stage valves and fires the engine; cutoff of the steam ejector as soon as the chamber

TEST STANDS (above) are of open construction with sloped roof to permit quick escape of gaseous hydrogen in case of fire. No important equipment is installed overhead. Below, three XLR 115 chambers are formed of stainless steel tubing. Engine uses regenerative cooling. Extremely low temperature of liquid hydrogen even during combustion process causes nozzle to shrink during firings.



has fired. Fuel for tests is pumped more than 2,000 ft. in vacuum-jacketed pipelines from the Air Products plant.

Diffuser has a long, double-walled, water-cooled throat of stainless steel through which the exhaust gases flow at a velocity of about Mach 4.5 and less than one pound of pressure. One steam ejector services the two test stands in the north test area and a second will serve the two south area stands, which will be in operation within a few weeks.

Next step will be to place the complete engine in a chamber so that the engine as well as the exhaust stream are enclosed in a simulated space environment. This chamber is being constructed now at the south stands.

Despite the widely held view that liquid hydrogen is a difficult, dangerous fuel to handle, Pratt & Whitney project personnel express extreme confidence in the relative ease with which it can be stored, transferred and used.

This confidence is based on having used several million gallons of hydrogen in development work since 1956, compared to what the company believes is small numbers of thousands of gallons for its competitors. (This experience with hydrogen was described last week at an ARS meeting; see below.)

"We also feel that we're well along in actual hardware development for flight articles, compared to the laboratory phase for other companies," XLR 115 project engineer Dick Mulready said. Mulready and many other project engineers came to Florida to staff the new research center last year after experience in hydrogen research and development work with Pratt & Whitney Aircraft Division and the parent company, United Aircraft Corp.

United's Research Department began work with hydrogen as an aircraft fuel early in 1955 under a Wright Air Development Center contract to investigate combustion characteristics and performance with various oxidizers. These studies also demonstrated feasibility of handling and using hydrogen in aircraft on a small scale.

Work was accelerated greatly early in 1956 when the Pratt & Whitney Division was awarded an Air Force contract to develop a liquid hydrogen engine. Work there and with other contractors advanced technology to the point that in the fall of 1958, ARPA ordered USAF to contract for the XLR 115. Last July 1, direction of the project moved to NASA, with USAF still handling contract administration.

By the time engine development was ordered, the company already had developed a liquid hydrogen pump capable of continuous operation at 1,100 psi. of output pressure.

After considerable small-scale test work with fluorine as an oxidizer, Pratt & Whitney has rejected it in favor of liquid oxygen for the XLR 115 because they feel its corrosiveness, toxicity, etc., outweigh its slight propulsive advantage.

Space Technology

Liquid Hydrogen Nears Operational Status

By Michael Yaffee

Columbus, Ohio—Liquid hydrogen is now ready to take its place as an operational propellant, scientists and engineers learned at the American Rocket Society's propellant thermodynamics and handling conference at Ohio State University.

The conference was told what happens when large quantities of liquid hydrogen are spilled and ignited, and learned that liquid hydrogen is neither exceptionally dangerous nor excessively hard to handle; that, in fact, it can be made, shipped, stored and used in large-scale engine development programs generally with less trouble than most cryogenic fluids or even gasoline.

Other information that came to light both inside and outside the meeting rooms included the following items:

• **Hydrogen's high energy** teammate, liquid fluorine, is still a comparatively hazardous chemical but is now considered safe to handle at isolated launching sites in quantities large enough to meet the oxidizer requirements of present IRBM-size rockets.

• **Rocketdyne reportedly** has selected an isolated section of Edwards AFB as the site for static firing its large scale fluorine rocket engines. National Aeronautics and Space Administration may go to the same area for the same purpose but hasn't definitely decided yet.

• **Olin Mathieson** has developed still another high energy boron fuel, HEF-5. Its future, like that of HEF-3 (the operational boron fuel which would be used in the afterburner of General Electric's J93) and HEF-4, also still in the development stage, apparently rests on the recommendations that A. D. Little will make in its government-contracted evaluation of the whole boron fuel effort (AW July 13, p. 23).

• **Acoustica Associates, Inc.** has a NASA contract for work on thrust control in a solid propellant rocket. The idea is to use sonic energy to control burning rate of solid propellant grains.

• **Strong resurgence** of interest in hot water and steam rockets, currently under way, stems from the extremely low cost of such devices. Among the principal applications now being suggested for water-powered rocket engines are RATO units, retrorockets on reentry vehicles (where aerodynamic heating could be used to advantage in converting water to superheated steam, with the vehicle being cooled in the process), and in low cost, low energy requirement, research rockets.

• **Recent BuAer** $100,000 contract to Stauffer Chemical Co. for work on a high energy monopropellant—the third contract since 1957—is aimed at the development of a storable liquid monopropellant with a specific impulse better than that of present day liquid bipropellants. This means above 260 sec. and Stauffer sees a possibility of reaching 300 sec. The monopropellant is expected to incorporate boron, hydrogen, fluorine and, possibly, nitrogen in a single compound. Nitrogen would serve simply as a carrier for one or more of the other elements.

• **ARPA contracts** awarded since last fall for the development of high energy solid propellants are aimed at obtaining materials with specific impulses of 280 sec. according to Rear Adm. John E. Clark, ARPA deputy director.

• **Under assignment** from the Secretary of Defense, ARPA has initiated a broad program on basic research in new high temperature (in the neighborhood of 6,000F) materials. Present solutions to the aerodynamic heating of re-entry vehicles still leave much to be desired. Materials program will be confined to universities in the hope of increasing the current number of graduate students.

• **ARPA has more than** 50 separate projects now going in its ballistic missile defense program, some of them looking as far ahead as 1980. Adm. Clark also pointed out that the nuclear-powered Savannah, like most commercial ships built with government funds, will have its decks reinforced in certain areas for the installation of missiles in time of war.

One of the biggest roadblocks to advancing the usage of liquid hydrogen had been the fear of fire and explosions. USAF had been treating liquid hydrogen as an explosive. Large quantities of the liquid—more than 50,000 lb.—had to be separated by at least 800 ft. Among other things, this made on-site storage of the material awkward, assuming that the missile men could find a large enough site to begin with.

Asked by the Air Force to undertake an appraisal of the fuel's dangers, Ar-

thur D. Little, Inc., concentrated on large-scale spillage of the type that might occur if, say, a 50,000 lb. storage tank at the launching site collapsed, letting the liquid hydrogen loose to form a tremendously large explosive mixture with the surrounding air. Although pipeline leaks, the freezing of air, and the impact of hot fragments were other dangers associated with the use of liquid hydrogen, large spills were considered the most critical.

In experiments carried out in an isolated section of Cape Cod, Mass., researchers found that spilled liquid hydrogen rapidly vaporizes and mixes with the surrounding air and that this mixture will burn readily and rapidly but will not explode when ignited by a spark, such as from static electricity.

Further, they found that the flame from the liquid hydrogen fire sets up strong convective currents, the fire and flame going almost straight up, and is not greatly affected by external winds. Other significant findings were that liquid hydrogen evaporates much more quickly from a bed of crushed stone than from sand and that it takes a shock wave source, such as a blasting cap, to cause the liquid hydrogen-air mixture to actually detonate, rather than burn.

As a result of these experiments, investigators decided that most of the fears concerning the dangers inherent in the large-scale use of liquid hydrogen along with the resultant safety precaution were exaggerated. More specifically, they concluded that 60 ft. is a safe separation distance for large (50,000 lb.) quantities of liquid hydrogen; that thermal radiation rather than detonation is the main hazard when dealing with large spills of liquid hydrogen; and that test stands or launch pads should be constructed to allow for the vertical burning characteristic of liquid hydrogen fires and for fast evaporation of spilled liquid hydrogen from the pad base.

Another drawback of liquid hydrogen that has now proven less formidable than anticipated is price. Through what one Air Force spokesman credits as some pretty ingenious work, Air Products, Inc., is able to produce liquid hydrogen from crude oil or natural gas for somewhat less than $5/lb. While this is not cheap when compared with the kerosene type fuels now going into most large U. S. missiles, liquid hydrogen is not intended for routine missile applications.

Currently liquid hydrogen is being carted across country in 6,000-gal. truck trailers with only small evaporation losses, thus deflating another anticipated drawback—the difficulty of insulating this extremely low boiling point liquid. Larger trailers are expected to be in use shortly. But when large-scale applications materialize, liquid hydrogen most likely will be generated on site to save the extra $1/lb. it costs to truck the material across the United States.

Pratt & Whitney has undoubtedly had more experience in handling liquid hydrogen in connection with engine development than any other company in the country.

At the meeting, Don Robin, chief of experimental test operations engineering at P&W's West Palm Beach facility, told of some of the more significant things P&W has learned and done in its development of hydrogen-fueled engines. Highlights of his report included the following:

• **Pratt & Whitney** has constructed and is now operating 16 highly specialized test stands equipped with cryogenic plumbing, high pressure gas purge systems and completely new types of test instrumentation. Finding as did Arthur D. Little that an open liquid hydrogen fire creates a strong upward draft, P&W designed its stands so as to have no important equipment overhead.

• **Tests currently being run** at the Florida facility commonly involve the pumping of 50,000 gal. of liquid hydrogen in a single test. P&W has developed pumps that can move more than 700 gal. of liquid hydrogen per minute against head rises of over 33,000 ft.

• **Due to its low density,** hydrogen can be transferred through pipelines at very high velocities and with low friction losses. In the half-mile transfer line between the Air Products and P&W plants, hydrogen moves along at the rate of 400 gpm.

• **Purging of pipelines** is a prerequisite to the routine use of liquid hydrogen in engine and component testing. Piping must be clean of dirt and foreign material but not to the same high degree that is required of oxygen or fluorine piping whereon a fingerprint may constitute an incendiary hazard.

• **On the P&W test stands,** the rocket engines get low-pressure liquid hydrogen directly from 5,000 gal. Dewars. Thrust chambers, says Robin, must be supplied with hydrogen at a pressure equal to the engine pump discharge pressure.

• **All test stands** are furnished with gaseous nitrogen and hydrogen for purging and pressurizing; liquid nitrogen for cold shocking and pressure testing; and liquid oxygen for combustion. Liquid oxygen is supplied to the engine from a trailer located on the opposite side of a barrier from the fuel source and lines.

• **Liquid hydrogen tanks** and lines are connected to a test stand vent system which carries excess hydrogen to a simple vertical burn stack with a propane igniter on top located in a remote area. Formerly, it was considered necessary to first vaporize the liquid fuel and then burn it as a gas. This led P&W to the construction of an elaborate burning system which is no longer required.

• **Primary requirement** in all hydrogen test stands, reports Robin, is adequate ventilation. Because hydrogen gas rises quickly and becomes trapped under gable type roofs, Pratt & Whitney stands have shed roofs and little or no side wall.

• **In tests involving** both hydrogen and oxidizer, the test stand is operated from a control room 900 ft. away.

• **Control rooms** are maintained at slightly positive pressure to prevent leaking gas from entering. Intake of the control room ventilating system is kept low and at least 100 ft. from the test stand, generally upwind.

• **Liquid hydrogen leaks** are easily detected owing to the formation of ice crystals and water vapor around them. P&W continues tests in the presence of small leaks even after they have caught fire as long as the flame is in open air and not endangering other parts of the system.

It does not react with materials commonly found around test stands including such things as air, oil and oxygen. It does not deteriorate or decompose in long-time storage. It is non-toxic, non-irritating and non-corrosive. The two principal precautions in handling liquid hydrogen—and they are important ones—are guarding against all possible ignition sources and against entrapment of the fuel.

In regard to hydrogen's high energy propellant partner, liquid fluorine, the most significant report, perhaps, was that on the recent Air Force experiments with fluorine spills carried out by Allied Chemical and the Chemical & Metallurgical Sections of Edwards AFB Rocket Engine Test Laboratory.

In an isolated section of Edwards AFB called Haystack Butte, large quantities of fluorine were purposely spilled on a test pad. Ignition was instantaneous. From these experiments, the Edwards group learned that soda ash and water fog were very effective in cutting down contamination from fluorine fires. In the case of an uninhibited fire, a 1,600-lb. liquid fluorine spill spread dangerous fluorine ions as far away as six miles. Use of sodium carbonate (soda ash) reduced this range roughly to ¼ mi. while a water fog took it down to approximately 150 ft., reported N. J. Vanderhyde and Lt. R. P. Rickey of Edwards AFB. The amount of water used however, is important. If an excess is used, it will wash the hazardous hydrogen fluoride that is formed back to the ground. They also found that a small weather station is essential to a fluorine test site, primarily to pinpoint wind direction.

Blue Streak Keys British Space Effort

By Cecil Brownlow

London—More power than it actually needs to fulfill its strategic mission is being designed into the de Havilland 3,000-mi.-range Blue Streak ballistic missile in order to provide Great Britain with an adequate booster vehicle for its entry into the space race.

Desire for as much power as possible for space applications was one of the major factors behind the British Ministry of Defense decision to rely upon the more powerful liquid propellants available, rather than the easier-to-handle solid fuels which would fit more readily into its plan to place the single-stage Blue Streak on hardened bases. Powerplant development is being carried out under the direction of Rolls-Royce, Ltd.

The United Kingdom, a top Defense Ministry spokesman said recently, will be forced to go into space "whether we want to or not" if it is to retain its status as a military power.

To get there, Britain wants its own booster vehicle as a positive demonstration of its advanced technology for public consumption both at home and abroad. And, over-all, the Ministry of Defense will date the United Kingdom's appearance as a missile power from the time of the appearance of the first operational Blue Streak in the early 1960s, despite the location of 60 U. S.-developed Thor intermediate range ballistic missiles in England under joint USAF-Royal Air Force control (AW July 13, p. 29).

Under the concepts laid out in the Ministry's 1957 White Paper, Britain's V-bomber force will be gradually phased out with the appearance of strategic missiles. This plan, Ministry spokesmen say, "remains essentially the same." It does not apply to the Thor, however, since the British do not consider it their own, and no cuts are planned in the bomber force before the appearance of the Blue Streak.

"We regard the Thor," Defense Ministry spokesmen say, "as an addition to our (North Atlantic Treaty Organization) effort. It's an American rocket with an American warhead. It's a contribution to the over-all nuclear backing to NATO.

"The Blue Streak, on the other hand, is ours . . . We can move it all over the world, and we regard it as an addition to our (British) deterrent."

Blue Streak Bases

Most probable locations for Blue Streak sites outside the British Isles are in Malta and Cyprus in the Mediterranean. From Malta, the Blue Streak could reach beyond Moscow and Leningrad and effectively sweep the Dnieper River missile complex. From Cyprus, it could impact on points well inside Asian Russia and at sites beyond the Ural mountains. Bombers equipped with a nuclear capability already are stationed in Cyprus in support of Britain's Baghdad Pact commitments and may be succeeded by the Blue Streak as the White Paper concepts begin to take force.

Just how far the British will go, however, in replacing manned aircraft with missiles is still a matter of debate and wide interpretation within Defense Ministry and Royal Air Force circles. A Defense Ministry spokesman instrumental in the drafting of the White Paper, who still contends that "I don't see anything that will justify a basic change" in the plan, concedes that manned bombers will be needed "for a long time to come."

Air Marshal Edmund C. Huddleston, the RAF's vice chief of air staff, is more emphatic. "I submit to you," he says, "that we have a long way to go yet before the manned vehicle is phased out."

Within the air staff, Marshal Huddleston adds, "there are no doubts at all as to a continuing place for manned vehicles. One reaches the point where you have to introduce the human element to overcome mechanical defense devices. Man also is more reliable than unmanned vehicles."

In the air defense field, Huddleston also believes that there will be a continuing need and place for the manned aircraft despite the White Paper's emphasis on replacing them with missile systems. "We are," he says, "quite convinced here that it will be essential to keep manned aircraft to go up and interrogate any possible target that appears on the radar screen. A missile can't do this."

The Thor, and the Blue Streak to follow, fall under the auspices of the RAF Bomber Command, Britain's primary deterrent force and the only one now possessing a nuclear weapon delivery capability.

Present backbone of the Bomber Command is its V-bomber force of Vickers Valiants, Avro Vulcans and the newer Handley Page Victors which have been coming into the operational force for the past year.

Although the command has begun to experiment with air-to-air refueling techniques, using converted Valiants in order to increase its effective range, primary reliance is placed upon fast strikes against targets in the Soviet Union and satellite complex and a return to base without refueling. This gives the force an effective combat radius of approximately 2,000 mi.

Unlike the U. S. Strategic Air Command, the command operates its force of V-bombers and Thor IRBMs on the assumption that it will receive an ad-

Westland, Saunders-Roe Merger

London—Largest helicopter manufacturing concern outside the United States will result from acquisition by Britain's Westland Aircraft, Ltd., of Saunders-Roe, Ltd.

Westland is paying some $4.8 million—$280,000 in cash and the rest in a new issue of Westland stock—to acquire the whole of Saunders-Roe issued capital.

The move—one of the biggest-amalgamations in the United Kingdom aircraft industry for some time—will bring the helicopter activities of the two firms under one integrated management. It is in accord with the U. K. government's general policy for rationalization and strengthening of the aircraft industry, as Westland Board Chairman Eric Mensforth noted in a letter to his stockholders.

Saunders-Roe's most publicized recent development is the Hovercraft. It is also prime contractor for the Black Knight missile. The company currently has two light helicopters in production—the Skeeter and the P.531.

Westland, which has concentrated more on helicopters than has Saunders-Roe, now has four main types in production or under development—Whirlwind, Widgeon, Wessex, and the giant Westminster.

De Havilland, which owns about a third of Saunders-Roe capital, is selling out to Westland. It is acquiring in return two non-aviation facilities of Saunders-Roe—Saunders-Roe (Anglesey), in marine and general engineering, and Saro Laminated Wood Products, in plastics.

Saunders-Roe has been in lean times recently. It was badly hit in late 1957 when government support was withdrawn from the SR.177, a supersonic interceptor. Production cutbacks at its plant at Cowes, on the Isle of Wight, have contributed to a serious unemployment problem there.

Westland indicates that some production work will be transferred from its plant at Yeovil to the Cowes facility.

vance notice of at least several hours, and probably up to 24 hr., from either political or military intelligence sources before an actual attack by missiles or manned aircraft.

Operating within this framework, British planners have discarded proposals that the Bomber Command adopt an alert system similar to that practiced by the U.S. 16th Air Force in Spain and the Seventh Air Division in England where crews are kept on constant alert while on duty—confined to their bases, driving specially painted station wagons and striving to get their aircraft into the air within 15 min. after receipt of an initial warning.

Instead, the majority of the Bomber Command's test exercises are conducted on the thesis that a 24-hr. alert of Soviet intentions already has been received.

From this point, the alert proceeds through two stages—Alfa, in which the crews get the order to report to their planes and prepare to disperse from their home bases which are known Soviet targets; and Bravo, in which groups of four aircraft each take off for dispersal fields in the United Kingdom and abroad.

In other tests, operating on the assumption that the warning time is too short to permit dispersal but still sufficient to permit crews to be alerted and collected together, the bombers have been put into the air in as little time as three minutes after the scramble order, and some top RAF officials believe the entire V-bomber force could be launched within 10 min. under dispersal conditions.

They add that, even without the advance notice they anticipate, they could scramble the majority of their aircraft within 40 min.—the warning time they rely upon the radar network located within England itself to provide against a manned bomber attack from the Soviet Union or its satellites.

The Bomber Command's alert concept would be rapidly changed, however, if and when the Soviets begin to establish ballistic missile bases within their East European satellites or effectively extend the range of their operational intermediate range missile systems.

British intelligence credits Russia's present stock of IRBMs with an effective range of 650 mi., not enough to reach the United Kingdom from their bases within the Soviet Union, and believes that Russia's stock of ICBMs will be directed exclusively against the U.S. in the event of nuclear war. Warning time Britain would have from the instant a ballistic missile is fired from a base located in a satellite country is estimated at between seven and 15 minutes.

Navy Launches Polaris AX-11

Navy-Lockheed AX-11 lifts off the launching pad in 11th test of a full-scale Polaris test vehicle from Cape Canaveral, Fla., earlier this month. The vehicle was destroyed by the range safety officer approximately 73 sec. later after a fractured jetavator caused it to veer off course **(see p. 23)****.**

British May Order Military Rotodynes

London—Probable military orders for the Fairey Rotodyne and the British push for lower air fares were the main points made in a House of Commons debate on air policy.

Labor Party efforts to get government admission that policy toward the "lame duck" aircraft industry needs overhauling got nowhere. Government spokesmen denied the need exists for a committee of inquiry, and passed over a suggestion for a Ministry of Aeronautics.

Minister of Supply Aubrey Jones said that a military order for the Rotodyne will be placed, provided there is satisfactory agreement on specifications, cost and delivery dates.

Jones said he hoped a firm order for six Rotodynes would be placed in the "very near future" by British European Airways, following up a letter of intent issued last January.

Jones used the Rotodyne as an example of government efforts to tie in military with civilian demands in order to increase the market for new British aircraft. An inadequate market—not alleged government "niggardliness" with financial aid—is the industry's central problem, he said.

The supply minister also said the government now is considering how to place detailed design work for a supersonic long range airliner with a minimum capability of Mach 2.

Jones spoke of inroads of American equipment into the European military market, partly the result of tie-in with U.S. aid, and urged British companies to combat it by linking with European aircraft firms.

In discussion of British airlines, Minister of Transport Harold Watkinson stressed intention of British airlines and the British government to push for air fare reductions at the September meeting of International Air Transport Assn. He implied that the British might withdraw from IATA if the push is unsuccessful.

Satellite Awards

Washington—Defense Department last week announced the award of three contracts for design and development of major elements of a delayed-relay communications satellite designated Project Courier (AW June 29, p. 18; April 27, p. 28). They are:

- Philco Corp., Philadelphia, will develop satellite communications package, under a $3.6 million contract.
- International Telephone & Telegraph Corp., Nutley, N. J., will design ground-based communications stations under a $4 million award.
- Radiation, Inc., Melbourne, Fla., will design ground-based antennas under a $1.3 million contract.

Contracts were awarded by Army Signal Corps which will monitor the development for Defense Department's Advanced Research Projects Agency. Initial firing of a satellite to test elements of the Project Courier system is expected within a year at a relatively low orbit of about 500 mi.

Space Technology

Symington Demands More Space Data

By Ford Eastman

Washington—President Eisenhower was sharply criticized last week for not supplying Congress with more details on policies, programs and activities of all agencies involved in the national space program, in a report presented to the Senate.

Critical report was written by the subcommittee on Governmental Organization for Space Activities headed by Sen. Stuart Symington (D.-Mo.) and submitted by Sen. Lyndon Johnson (D.-Tex.), chairman of the Senate Committee on Aeronautical and Space Sciences.

Symington said the first annual report submitted by the President was essentially a summary of what had been accomplished during the first year by the National Aeronautics and Space Administration and that there was no projection beyond the current year.

Congress is charged with the legislative responsibility in the space field, Symington said, and in order to carry out its responsibility, it must have a comprehensive picture of the entire space program.

Symington said the law requires that the President develop a comprehensive program of aeronautical and space activities to be conducted by the agencies of the United States. Testimony before the subcommittee, however, indicated the existence of two space programs, one civilian (AW June 22, p. 119) and the other military, but no one over-all, complete program. There were also differences of opinion within various agencies as to what constitutes a comprehensive space program.

Comprehensive Program

This confusion should be dispelled in order to ensure the future receipt by Congress of the annual report required from the President, Symington said. Within the context of the act, he explained, a comprehensive space program means a planned course of action, present and future, designed to achieve all the objectives set forth in the declaration of policy by taking into account the needs and requirements of all civilian and military agencies engaged in space activities.

Without such a program, Symington warned, weaknesses in liaison and coordination will result which cannot help but adversely affect the successful achievements of the nation's space goals.

The report was also critical of the exercise of executive privilege, which it said "hinders the Congress from obtaining basic policy information" it requires to meet its legislative responsibilities. Activities and recommendations of both the National Space Council and the Federal Council for Science and Technology are considered confidential to the President, even though the subject matter is not classified or will not affect the national security.

Keith Glennan, NASA administrator, informed the subcommittee that he had discussed with the President the possibility of having the "privilege" removed but was informed by the President that he maintained his previous position and that such information would remain confidential.

The committee report recommended, however, that all facts pertaining to the national space program which could not help a possible enemy should be given to the American people. This would dispel the present unwarranted complacency, the report said, and keep the people properly informed.

Recommended Solutions

Other recommendations to resolve problems, which the committee said can be met by administrative action within the executive branch, are:

- **"Improvements should be made** in reports to the Congress in order that more complete information will be presented regarding the space policies, programs and activities of all agencies.
- **"A full-time executive** secretary to the Space Council should be appointed and a small competent professional staff named." Earlier, Glennan testified before the subcommittee that the President had not appointed the secretary or staff which the law provides, but had appointed an acting secretary who is on NASA's payroll. The staff is supplied by NASA and the Defense Department as required, Glennan said.
- **"Decisions should be made** and implemented concerning the future role and assigned areas of responsibility of the Advanced Research Projects Agency." Some witnesses questioned the need to continue ARPA, while others suggested alternate proposals for the performance of its functions.
- **"The various space roles** and missions of the services—Air Force, Army and Navy—should be clarified." The existing pattern of organization and administration of space activities within the Defense Department, the report said, creates problems for the respective military services in the formulation of plans, programs and budgets.
- **"Authority and responsibility** for handling coordination between NASA and the Defense Department should be given the Civilian-Military Liaison Committee." Subsequent to the conclusion of the hearings, and prior to the report, the President approved a revised charter for the Civilian-Military Liaison Committee to strengthen the group along the lines recommended by the space subcommittee.
- **"Planning and programing** for research and development should be accelerated. Priorities and necessary funds should be given to important programs." Considerable testimony was given to the subcommittee to the **effect that expenditure** limitations are forcing cutbacks in research and development programs in the Defense Department.
- **"A comprehensive space program** should be prepared and maintained, both on a current and projected basis.
- **"Some effort to avoid** duplication in specific programs and operations has been made by both NASA and the Defense Department. The testimony indicated, however, that there should be a great deal more effort to coordinate military and civilian space policies and programs.
- **"Space activities within** the Defense Department cannot be managed effectively by changes in the organization and administration of the space program alone. Such changes can only be effective if they are an integrated part of a further unification of the services within the Defense Department."

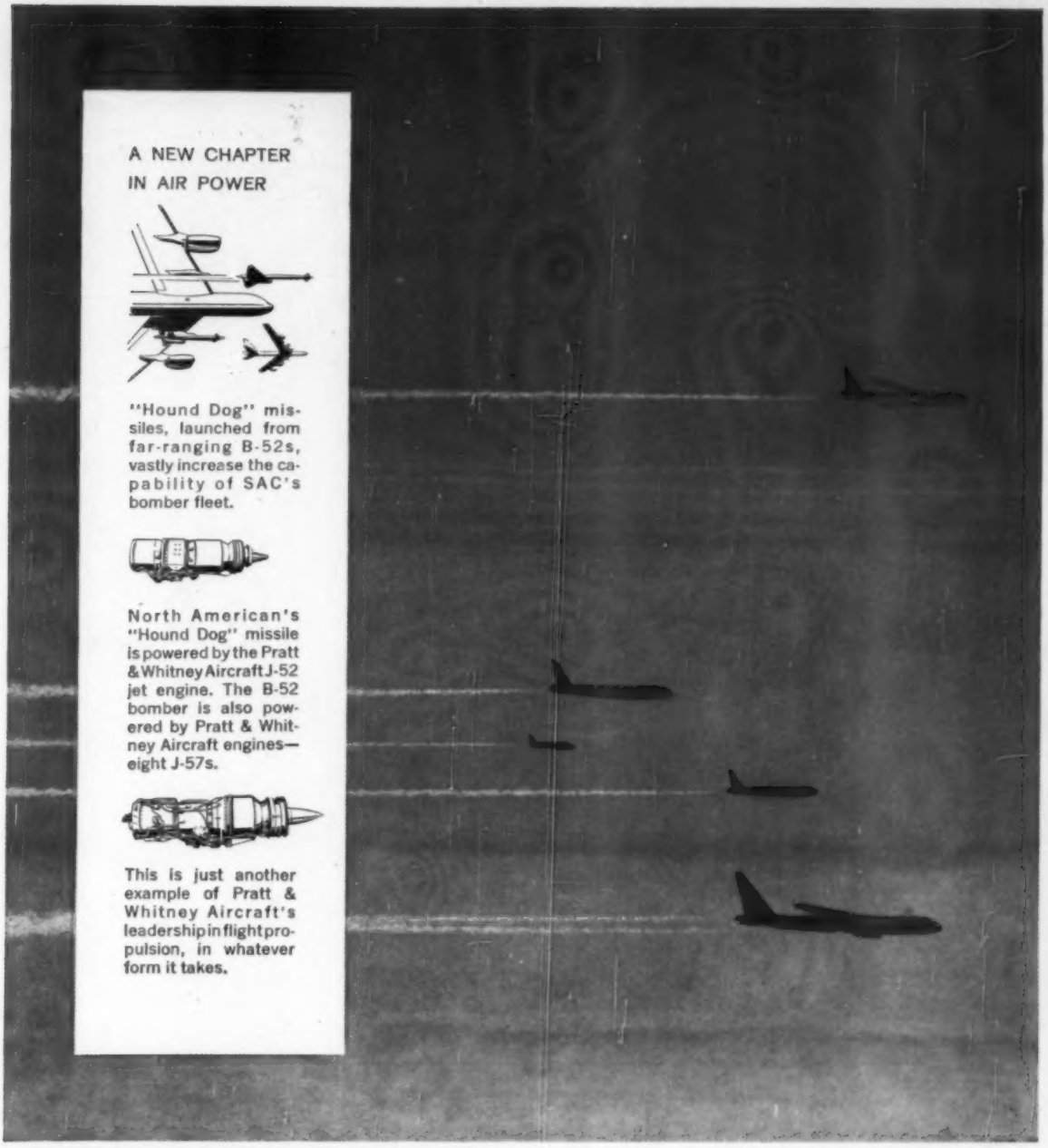
The committee also said that the National Aeronautics and Space Act does not require amendment at this time. It has been in force for less than a year and therefore has not been fully tested, the committee reported.

Germans Construct Jet Research Center

Bonn—Construction of a new German aviation research center, which will cost about $20 million, has started at Wahn Airport, near Cologne.

Initial construction comprises two institutes for jet propulsion and thermodynamics and for applied gas dynamics. Supersonic wind tunnel for tests in excess of Mach 5 is planned for 1960; a vacuum installation will be added later to boost test speeds to Mach 10. Present plans call for eventual construction of a transonic wind tunnel.

The new center will become the research headquarters of Deutsche Versuchsanstalt fuer Luftfahrt (DVL), which now maintains five aviation research centers in Aachen, two in Munich, five in Essen-Muelheim and one in Bonn. Most of the Aachen centers will be moved to Wahn, along with institutes for material testing, propulsion dynamics and aviation mechanics.



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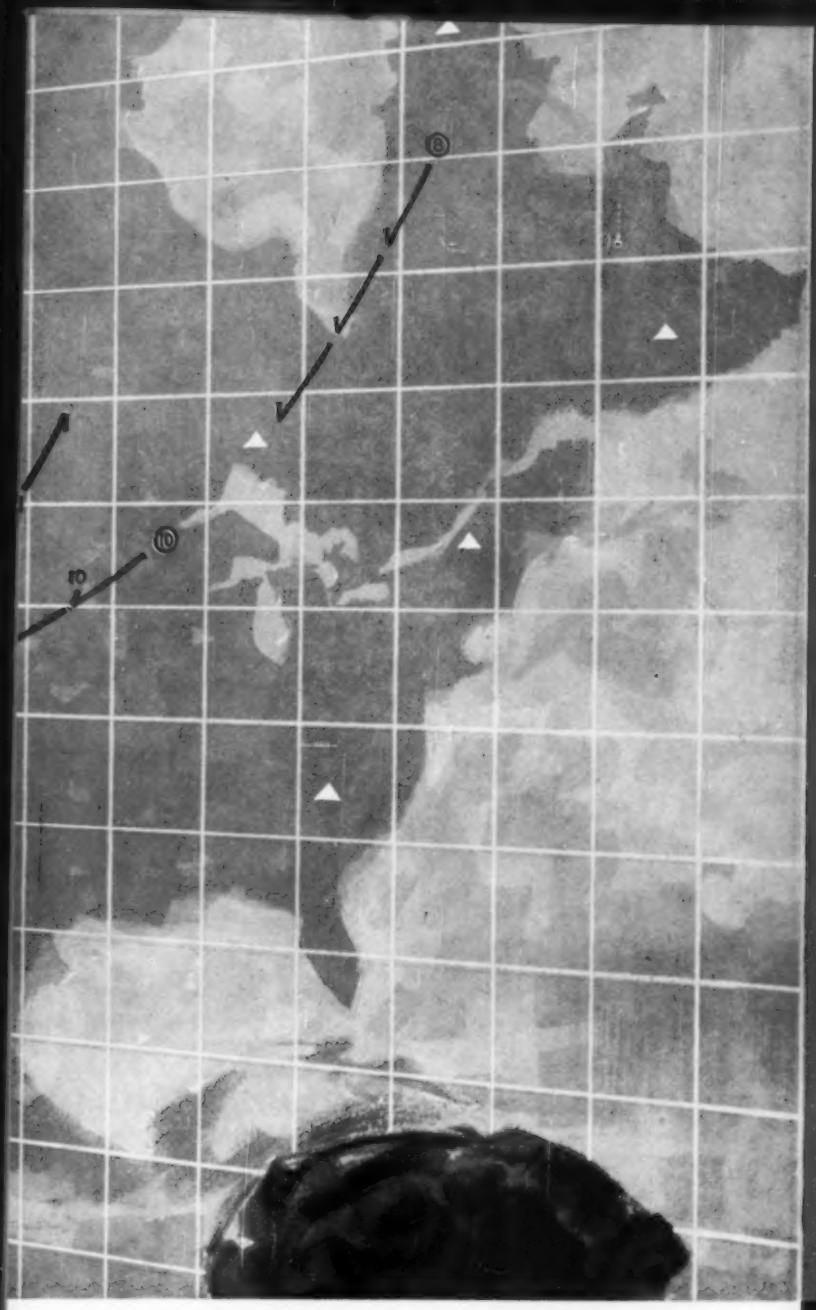

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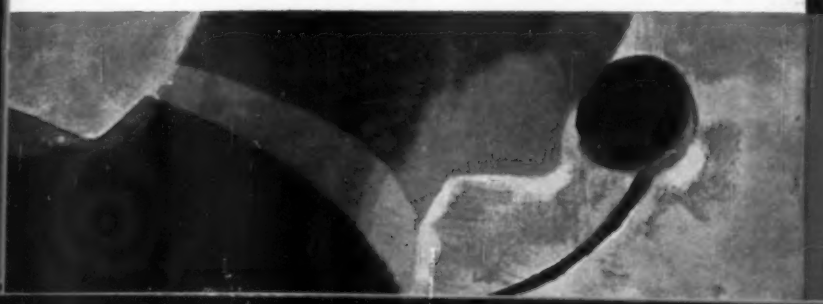

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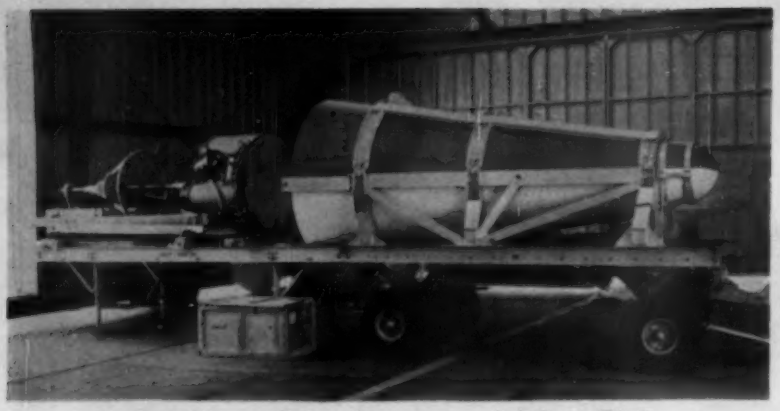
Juno II vehicle carrying Explorer VI radiation satellite was destroyed over Pad 5 at Cape Canaveral, Fla., at 12:38 p.m. EST July 16 after inverter failed at liftoff, causing loss of control of booster. Fuel tank has just been ruptured.

Failure of Juno II Attributed to Faulty Inverter

Apparent failure of an inverter in the modified Army-Chrysler Jupiter booster of the Juno II vehicle aborted an attempt to launch National Aeronautics and Space Administration-Army Ballistic Missile Agency Explorer VI radiation satellite. Inverter designed to convert 24-v. direct battery current into alternating current of a desired frequency and voltage for a vital control function, failed at liftoff. Range safety officer destroyed the missile five or six seconds later. Wreckage scattered over 600 ft. Grass fire that resulted set off 15 solid rockets used in upper stages, sent smoke through an air intake into blockhouse momentarily. Payload was thrown some 300 ft., transmitted for total of seven seconds. Despite shock and fire damage, some components may be re-used if another Juno II vehicle, shown at right in ABMA assembly shop, is assigned for a second launch attempt. Damage to Army launching pad was slight.

Juno II is assembled in Army Ballistic Missile Agency shop prior to July 16 launching.



Atlas Nose Cone Recovered After Firing

Atlas intercontinental ballistic missile nose cone, similar to the cone from USAF-Convair Atlas 8-C which was recovered after a firing last week, is partially disassembled during preflight inspection at General Electric hangar at Cape Canaveral, Fla. Equipment at rear of the cone is parachute and recovery kit. Atlas 8-C flew 6,300 mi. over Atlantic Missile Range for the missile's first success in six launches and first recovery of a nose cone after flight over the intercontinental range. The Atlas was heavily instrumented to pinpoint a fuel flow problem that caused failure of Atlas 5-C and 5-D and might have aborted three other flights in the last five attempts, if other trouble had not developed.

Greater Subsystem Competition Planned in USAF Procurement

Washington – Under congressional criticism for concentrating its procurement dollars on too few firms, Air Force last week told a Senate Armed Services Subcommittee it is taking steps to break up weapon system teams and stimulate competition. Under the plan, Air Force will:

- **Freeze design configurations** and contract directly with subsystem manufacturers.
- **After an advanced weapon** is stabilized, break out standard items from the original contractor for competitive bid.
- **Conduct separate design** competitions for major subsystems, particularly electronics.

Air Force Maj. Gen. W. T. Thurman, in charge of production and programming in the office of the deputy chief of staff for materiel, qualified: "Our policy is to try to give the contractor the maximum possible responsibility and freedom of action consistent with our final responsibility for procurement of an effective weapon system and management of tax dollars."

Thurman said USAF expects to pull the major subsystem manufacturers on the B-58 from under the direct control of Convair, now the single prime contractor, and contract directly with them in connection with the Fiscal 1960 purchase of 40 aircraft. There are 14 major subcontractors. An appraisal of the change is now under way. Thurman told the subcommittee headed by Sen. Strom Thurmond (D.-S. C.) that "the procurement of subsystems through the weapon system prime contractor in the development stage of the weapon does not necessarily mean that production items will be bought the same way. If configuration and integration problems can be sufficiently nailed down we may buy production versions of a given subsystem directly from its producer and furnish them to the weapon system contractor for incorporation in the end item."

Generally, when the design configuration is frozen, he said, "it is better for the services to buy from the company who manufactures the system. They can consolidate their requirements, they can buy in larger quantities."

J. M. Malloy, chairman of Defense Department's Armed Services Procurement Regulations Committee, told the subcommittee that "more and more" the standard units in missile and other advanced weapon systems will be withdrawn from the original contractor "to obtain widespread competition." Thurman also concurred that, in the ballistic missiles field, "when your configuration is firm you have got items that can be bid on by a lot of people . . ." Malloy reported that 23% of the dollar-volume of the Western Electric Co. contract on Army's Nike Zeus anti-missile missile program have been withdrawn for competitive bid contracting. The "broken out" portion, he said, is for items such as launchers, electric generators, batteries, compressors, motors.

In answer to congressional criticism that "the biggest say" in military procurement has been shifted to single prime contractors, Thurman pointed to the North American F-108 procurement program in which USAF first held a design competition for the fire control subsystem, won by Hughes Aircraft Co., and then "directed" North American to incorporate the Hughes system. He explained that the system "has not reached the stage of design stability which would warrant its being purchased directly by USAF and furnished to the weapon system contractor."

House Group Approves Nuclear Power Funds

Washington—House Appropriations Committee has approved funds for acceleration of Atomic Energy Commission's rocket and ramjet missile nuclear propulsion projects and nuclear auxiliary power project, but trimmed $3.7 million from Fiscal 1960 funds requested by AEC for aircraft nuclear propulsion.

Following are details on the committee's actions:

- **Aircraft nuclear propulsion.** Committee approved $65 million of the $68.7 million requested by AEC for Fiscal 1960. With the $75 million in the Department of Defense budget, this would bring the total for ANP to $140 million for the year. AEC Chairman John A. McCone reported to the committee that "progress in this program over the last few years has appeared to be slow, and it has been expensive." He said there is "significant doubt" that the technical objectives "could be achieved within a reasonable time."
- **Rocket and missile propulsion.** The full $27.9 million asked by AEC to experiment in the feasibility of the use of nuclear power for rockets, Project Rover, and for ramjet missiles, Project Pluto, was voted by the committee. This is a $6.9 million increase over the Fiscal 1959 allocation for the two projects.
- **Auxiliary power.** The $12.1 million approved by the committee is $4.6 million over AEC's Fiscal 1959 budget for this project. In his testimony, McCone was optimistic on its prospects: "Two main approaches are under development. One utilizes the heat from the decay of a radioisotope, and the other uses a small reactor. The remarkable success of our recent Snap III device has led to serious consideration of Snap units for uses ranging from underwater applications to the eventual possibility of propulsion in space."

Pyle Hits FAA Budget Reduction As Hindering Recruitment Training

By Russell Hawkes

Los Angeles—Air traffic control equipment development program will remain on schedule but personnel recruitment training will be hindered if the House of Representatives' reduced version of the Federal Aviation Agency appropriation bill is passed, Deputy FAA Administrator James T. Pyle told the joint symposium of the Radio Technical Commission for Aeronautics and the Institute of Radio Engineers. Sessions were attended by about 420 engineers.

Pyle predicted that supersonic jet transports, whenever they arrive, generally will pose less of a problem to air traffic control and to the economy than did present subsonic jets. The event unquestionably will raise serious problems, he said, but the airways modernization program should have picked up enough momentum by then to cope with the situation. Pyle said he did not foresee supersonic jet transports before 1965.

Outlining technical problems facing the FAA, Pyle noted:

- **Study of technical factors** influencing cost of a transponder for air traffic control radar beacon system.
- **Operational characteristics** for a civil-military automatic landing system.
- **Analysis of autopilot** characteristics in relation to an automatic landing system.
- **Development of direct** pilot-to-meteorologist communications for general aviation aircraft.
- **Study of universal aircraft** address system for air-ground communications; that is, assignment of an aircraft identification which will serve for both data link and voice communications without the necessity of translation in automatic data processing systems.

Pyle said that this is the sort of problem upon which FAA will ask the RTCA executive committee to submit technical recommendations. He said that radar beaconry appears to be more promising to airborne anti-collision devices than infrared gear and that supersonic transports and communications satellites may lead to a single, national air route traffic control center.

In another talk, FAA's airborne collision prevention program was outlined by R. M. Buck, data acquisition branch, FAA Bureau of Research and Development.

FAA has formed a special collision prevention advisory group to press development of a means of airborne collision prevention in minimum time. The FAA-headed group plans to draw upon the talent and resources of other agencies and organizations having competence in the collision prevention field. The military services, Aircraft Owners and Pilots Assn., Air Transport Assn. and National Business Aircraft Assn. have been invited to participate. Representatives from the organizations must have experience in the field of collision prevention and must have the power to act on behalf of their organizations. All six agencies have accepted the invitation.

The advisory group will be concerned principally with airborne devices. At present, no manufacturers are represented. The group will see to it that the requirements of the various users are considered in FAA planning, will initiate a research and development program and will evaluate technical approaches and hardware.

Buck mentioned FAA's one-year contract wih Bendix Aviation to evaluate a cooperative collision avoidance installation using range and altitude information only, with the primary emphasis being on the ground reflection method of measuring range. Under the contract Bendix will assemble flyable basic equipment, perform the bench tests and perform enough flight tests to prove feasibility of technique. Flight tests will evaluate ground reflection method of range determination and check out RF and data-processing parts of the installation. Bench tests will be conducted to investigate the multiple target signal interference problem.

An effort then will be made to reduce the experimental equipment to a practical design. Project will involve parallel studies at 440 mc. and 1,630 mc. to obtain data about the effect of frequency on transmitted power for given signal to noise ratio. Under an Air Force contract, Fairchild will gather data at X-band, using Fairchild equipment that is now installed in an Air Force plane.

In the field of proximity warning indication, Buck said there is a simulation program underway to measure the ability of a pilot to locate, evaluate and successfully avoid intruding aircraft on the basis of PWI information. A fundamental question here is the degree of accuracy the pilot needs about an intruding aircraft to acquire the target visually, significantly earlier than he would otherwise.

F-106s at McGuire

McGuire AFB, N. J.—First U.S. Air Force squadron to be equipped with the Convair F-106 Mach 2 jet interceptor and armed with Hughes GAR-3 and GAR-4 Super Falcon missiles has started operations here, guarding the New York Air Defense Sector against attack by enemy bombers.

Still short of its full 25-plane complement, the 539th Fighter Interceptor Squadron, commanded by Lt. Col. Reginald L. Hays, currently has 15 single-seat F-106A's and one tandem-seat F-106B on site, four to eight of them deployed at any one time in alert hangars from which they can take to the air within five minutes.

News Digest

B. F. Goodrich Co. one-piece space suit will be used by Mercury space pilots in suborbital and orbital space flights. National Aeronautics and Space Administration, after more than six months of evaluating three manufacturers' suits, said it will order approximately 20 Goodrich suits for about $75,000. Six-man NASA selection board included Navy Lt. Cmdr. Walter M. Schirra, Jr., one of the space pilots.

National Aeronautics and Space Administration and Space Technology Laboratories will launch a satellite from Cape Canaveral, Fla., into a highly elliptical orbit about the first week in August. Satellite will carry a highly refined TV camera (AW Feb. 23, p. 26).

Omega Aircraft Corp. has completed a $200,000 contract for three BS-12D twin-engine helicopters with Okanagan Helicopters, Ltd. of Canada, bringing the company's order backlog to eight. Aircraft will make its first flight this week at New Bedford, Mass. Bernard Sznycer, Omega president, said certification will undoubtedly be completed by September.

Ryan Aeronautical Co. will study application of ultra-thin gage, high strength materials for vehicle operation at extremely high altitudes, under an Air Force contract. Basic concept centers on Ryan's Miniwate combination of corrugated and flat skins of high temperature-resistant alloys.

Boeing 707-320 Intercontinental jet transport last week was certificated for airline service by Federal Aviation Agency. Aircraft was certificated for maximum gross weight of 302,000 lb.; powerplants are four Pratt & Whitney JT-4A-5 turbojet engines rated at 15,800 lb. thrust each. Boeing has orders for 42 Intercontinentals.

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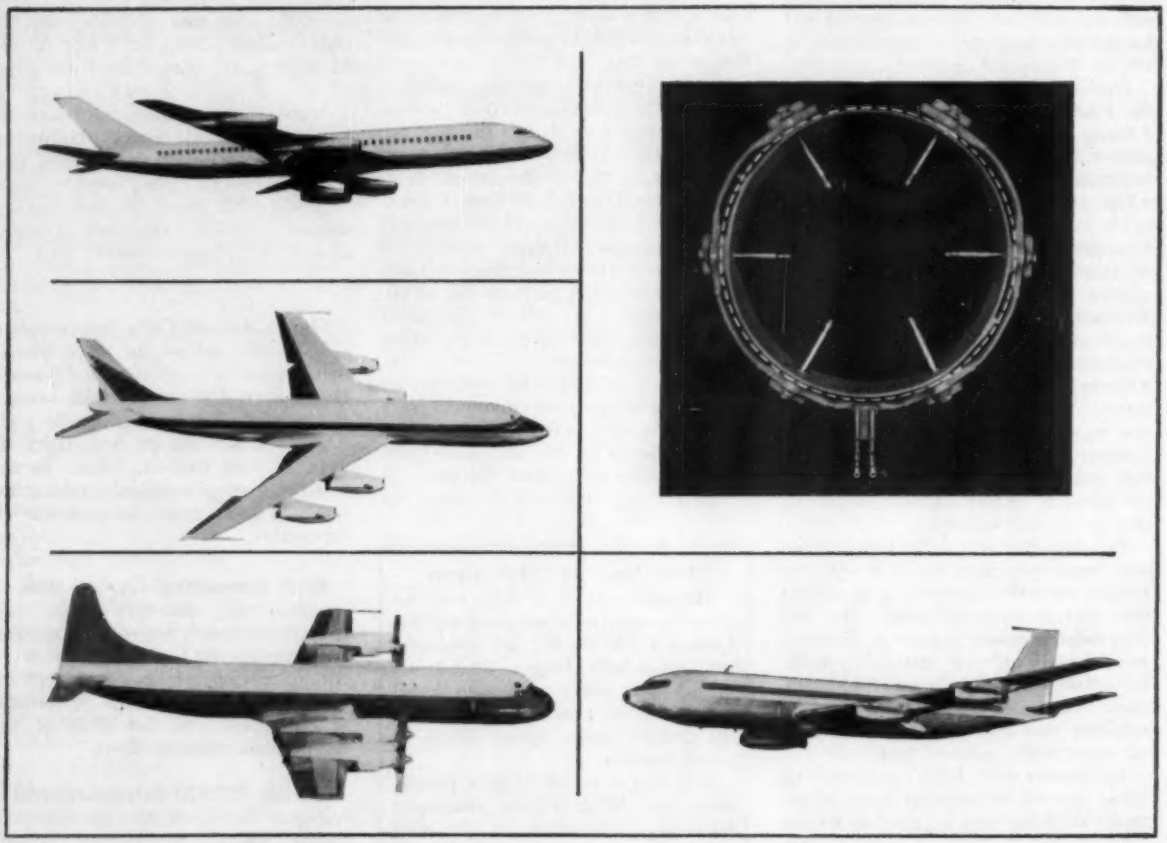

ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE... PRECISELY

FAA May Order Radar on All Airliners

Proposed order designed to reduce weather hazards; total cost to carriers could reach $27 million.

By L. L. Doty

Washington—Federal Aviation Agency, in a move to combat the growing number of accidents caused by severe air turbulence, took the first steps last week toward ordering all U. S. airlines to equip their fleets with airborne radar.

The action, taken in the form of a proposed rule making, would require all certificated airlines to purchase and install airborne weather radar on approximately 60% of the 2,077 transport aircraft now in operation within the next eight months. Potential cost of the conversion to air carriers, including supplemental as well as scheduled airlines, could run as high as $27 million.

Although the 350 DC-3s and the few Lockheed L-18 Lodestars now in passenger service are excluded from the proposed regulation, FAA is giving strong consideration to making the order a sweeping rule that will embrace all types of passenger-carrying transport aircraft.

According to FAA officials, the proposed regulation was prompted by these reasons:

- **Number of minor accidents** causing structural damage and injury to passengers during high-speed flights through hail storms and violent air turbulence has been the source of concern to FAA.
- **Strong possibility** that the Capital Airlines' accident near Baltimore on May 12 which took the lives of 31 persons (AW May 18, p. 41) was caused by the aircraft entering extremely strong air currents has focused attention on the hazards of turbulence. Radar on the Capital Viscount was inoperative at the time of the incident.
- **Success of United Air Lines** in virtually eliminating accidents attributable to turbulence through the widespread use of radar has demonstrated the value of radar in the safe conduct of flights.

Cost Estimates

Actual cost of the equipment and its installation for all air carriers will amount to $16 million. Spares and test equipment will add another $4 million to the over-all cost. Conversion of the DC-3s operated by certificated carriers, if required, could reach a $7 million cost, the vast majority of which would be borne by the subsidized local-service carriers.

Radar units are currently selling at a price ranging from $8,500 to $9,000 each. Installation costs vary widely according to the type of aircraft involved.

For example, Fairchild F-27 turboprop transports, which are included in the regulation, are normally instrumented for radar when delivered to the carriers if they are not already fully equipped with the units. Consequently, any installation costs to the airline will amount to little more than a few hundred dollars.

On the other hand, installation of the equipment on older type aircraft, such as the Lockheed L-049 Constellation, will reach an estimated cost of about $26,000 for each airplane.

High-altitude aircraft—turbojets and turboprops—coming off the production line are equipped with radar by the manufacturer under the terms of the contracts placed by the ordering airlines.

United Air Lines, which has had its entire fleet—including all-cargo aircraft—equipped with radar since November, 1957, began experimenting with airborne radar in June, 1953 when it installed a unit in a DC-3 which it dubbed Sir Echo.

A total of 40 test flights were conducted with the DC-3, and in September, 1954, United's board of directors authorized expenditure for the purchase of the units. Contract for the radar equipment was let with RCA.

Complete cost of the program amounted to $5 million, but United now feels that the initial investment eventually will prove to be self amortizing.

The carrier estimates that it has saved approximately $575,000 annually as the result of radar. About $150,000 is saved each year in fuel costs and in pilot flying time by cutting down on flight delays and eliminating wide-sweeping detours around thunderstorm areas.

Damage to aircraft from hail and turbulence has been virtually eliminated resulting in maintenance savings of about $400,000 each year. More than $25,000 has been saved by the carrier through the reduction in damage to instruments caused by static discharge.

Appeal Time

The proposed rule-making issued by the Federal Aviation Agency allows 60 days for comments from interested parties. If the regulation is adopted as a part of the Civil Air Regulations, carriers will be granted six months to undertake and complete conversion of their fleets.

According to the FAA, there is sufficient radar equipment available to prevent any delay in deliveries that would slow down the program.

DC-3s and Lockheed L-18s are excluded from the regulation because of its wording: "All aircraft certificated under transport category rules and carrying passengers shall be equipped with airborne weather radar . . ." Both the DC-3 and L-18 were certificated under Bulletin 7A, while all other transport aircraft have been certificated under the "transport category rules" or civil air regulation 4A issued in 1954.

Air Transport Assn. members will meet next month to discuss the proposed rule. Very little protest is expected, however, since a majority of the scheduled carriers already are voluntarily adopting radar as an operating necessity.

Assn. of Local Transport Airlines will consider the issue at its quarterly regional meetings which begin tomorrow in Anchorage, Alaska. Air Line Pilots Assn. has long advocated full implementation of airborne radar on all aircraft.

JT3D Flight Test

East Hartford, Conn.—First flight test of Pratt & Whitney JT3D turbofan version of the company's J57 turbojet was made here last week.

The military version of the JT3D was mounted in a North American RB-45 testbed and operated through its complete thrust spectrum at altitudes up to 30,000 ft. American Airlines and KLM Royal Dutch Airlines have ordered commercial models of the JT3D for installation in Boeing 707 and Douglas DC-8 jet transports. The American order will be used to retrofit aircraft which originally were powered by pure jet engines.

EXTERNAL differences between the A and B models of the Tupolev Tu-104 transports are shown with them parked side by side at Vnukovo. The Tu-104B being refueled in the foreground has 18 cabin windows with three slightly smaller and raised above the side striping just opposite the wing root. Aeroflot winged insignia is flush with upper side stripe. On the Tu-104A (right) there are only 15 cabin windows with only two raised over the wing. The Aeroflot winged insignia is close to the bottom side stripe. Forward cabin compartment has only four windows compared with five on the Tu-104B. Note the conveyor belt baggage unloading system on the Tu-104B at the extreme left, the self-propelled loading stairs and the large fuel truck required for the jet transports.

Aeroflot Faces Jet Airport Problems

By Robert Hotz

Moscow—Aeroflot's expanding jet transport fleet and international operations are forcing major operational changes ranging from ground handling equipment through landing aids, airport terminal facilities and runway construction. Some of these jet age problems, such as new ground handling equipment designed for the speed and volume of jet operations, have been solved with a speed that amazes foreign airline officials resident in Moscow. But other problems such as airport terminal and runway construction will remain an acute problem even if all the provisions of the current Seven Year Plan are fulfilled by 1965.

The airports in Aeroflot's far-flung system range from the relatively modern Vnukovo terminal outside Moscow, with a 9,000-ft. concrete main runway, GCA and ILS landing system, high intensity approach lights and radar traffic control, to grass fields and dirt strips with only a wind sock and a boundary fence to guide Aeroflot pilots. These grass fields are the rule rather than the exception once a traveler deviates from the jet service trunklines. At many of these grass fields, cows, sheep, goats, ducks and geese run loose without apparent interference with the air traffic.

A Tee of white ground panels is laid out on the grass to indicate the current landing direction, and a blue-uniformed airport employe is posted at the boundary fence waving a white or red flag to inform approaching pilots whether the field is clear of animal or air traffic. On a warm summer day in the Ukraine, the Caucasus or along the Black Sea, these grass fields have a sleepy bucolic air that belies the amount of air traffic buzzing in and out of them with Li-2, Il-12 and Il-14M equipment. The next higher class of airport has a single runway with all cross-wind operations using the grass.

AIRPORT PASSENGER TERMINAL at Alma-Ata in central Asia is typical of older style Aeroflot terminals. Note floodlights mounted on roof and tower to illuminate ramp at night and town lettering on tower in both Cyrillic and Kazakh alphabets.

Passengers Wait

When the wind stems from certain directions at some of these grass fields, the Aeroflot transports come to rest more than a half mile from the airport terminal building. Transit passengers then lounge in the shade of the aircraft wings while the copilot trudges to the airport building and gets his clearance, and cargo is unloaded. Nearby cattle pens or haystacks are used as emergency toilet facilities. Most Aeroflot ground stops on the grass field circuit are rigidly held to 30 min. from touchdown to takeoff.

In that time we observed an average of from three to six other arrivals and departures from each field, indicating the volume of traffic that even these primitive facilities handle.

Both Soviet airline and military pilots are experts at operating large, high-

performance aircraft out of dirt and grass fields. We observed several fighter strips outside Moscow, in Georgia an dthe Ukraine where MiG-17s and MiG-19s were being operated from dirt runways. Aeroflot pilots exhibited skill in landing and taking off tricycle gear Il-14Ms from grass fields holding the nosewheel off until most forward speed was killed on landing and horsing it off the ground almost immediately after the takeoff run began. At Frunze, capital of the Kirgiz Republic, the single paved runway was under repair when we arrived. The Aeroflot pilot set his tricycle gear Il-14M down on the adjacent sod and took off again from the same surface with the same nonchalance that he used on the paved runways at Tashkent and Alma-Ata.

Dirt Runways

Kiev is the third largest city in the USSR with a population well over a million and maintains one of the most rapid urban growth curves in the country. It is a major air traffic hub, yet it is still served by a once grassy field that heavy traffic has worn into dirt grooves of heavy mud or thick dust, depending upon the weather. There are plans to build a new modern airport and terminal building at Kiev in the Seven Year Plan (see artist's drawing on p. 49) but no one in the city seems to know when construction on this project will begin.

In the meantime, this key passenger traffic center is served by 15-passenger Li-2, 21-passenger Il-12 and 24-passenger Il-14M twin-engine piston transports. More than a dozen An-10A four engine turboprop transports also operate off the dirt field on daily cargo schedules for their final operational shakedown prior to beginning passenger service. Both Il-18 four-turboprop and Tu-104 twin-jet transports were observed parked on the Kiev dirt field, indicating that they were able to operate on it at least experimentally.

Aeroflot officials claim they will operate the 100-passenger Tu-104B soon on the Kiev-Moscow and Kiev-Leningrad runs despite the lack of airport improvement at Kiev.

Total of 90 new airports suitable for jet operations with modern passenger terminals and radar traffic control systems are scheduled for construction during the current Seven Year Plan. But even this construction program will leave many large cities with grass airports, and the An-10A has been specifically designed to serve this type field.

Watching the An-10As take off with normal cargo loads from both the dirt field at Kiev and the concrete runway at Vnukovo, it was difficult to detect much difference in their takeoff run, rate of climb out or landing run with reverse pitch propellers on the different

AIRPORT AT TASHKENT is a postwar structure consisting of large center hall and two rectangular wings connected by open galleries. Note modern bus operated by Aeroflot to carry passengers downtown, Volga type taxi (center) and Zim Intourist limousine (left).

CONSTRUCTION IS PROGRESSING on a new building at Vnukovo airport to house Aeroflot offices and provide more space for foreign personnel whose airlines now operate into Moscow. Aeroflot maintenance hangar is in left background.

CHR INFLATABLE RADOMES PROTECT NIKE MISSILE TRACKING SYSTEMS

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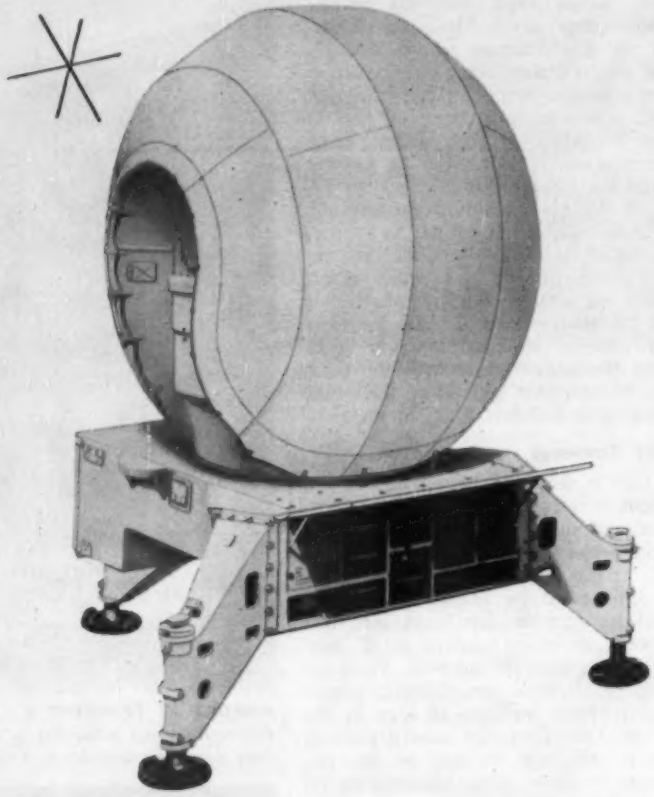

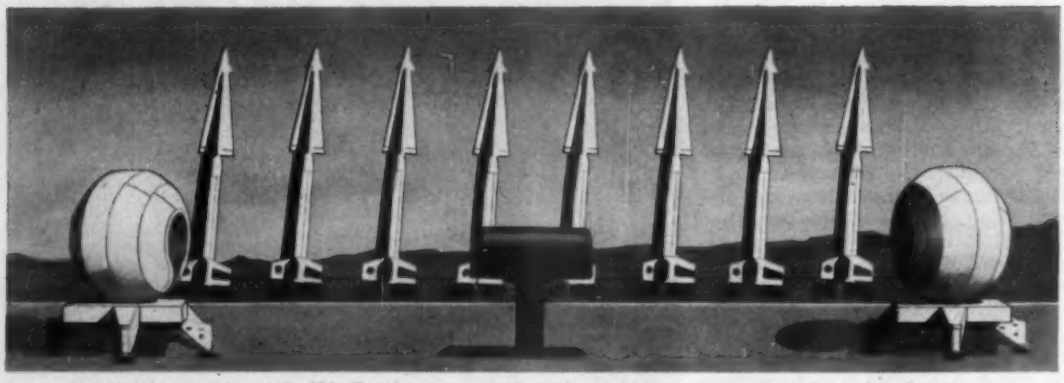

Artist's conception of the Nike-Hercules system; showing radar tracking equipment and missiles used to destroy any manned aircraft or cruise-type missile known.

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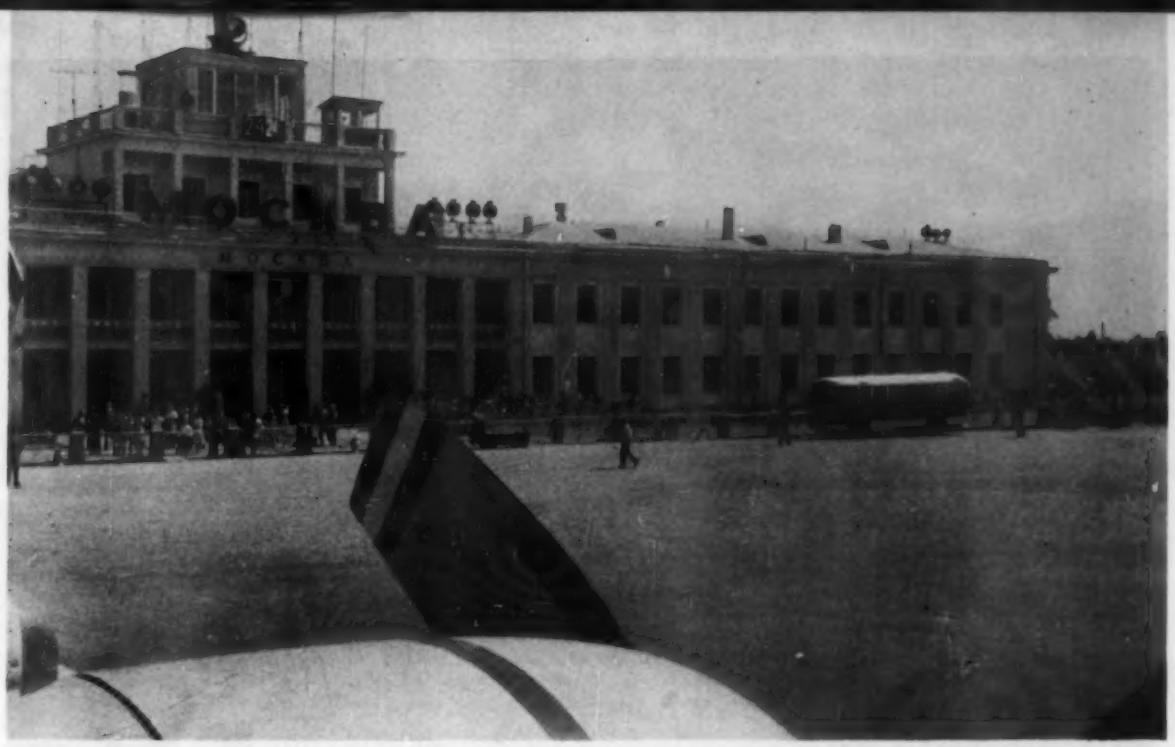

ONE OF THE TWO wings added to Moscow's Vnukovo passenger terminal is visible in this photograph taken from a USAF C-118 on the departure ramp. This wing houses expanded domestic traffic; wing on the left side of the terminal was built for international traffic.

surfaces. The extremely short takeoff run and high rate of initial climb apparently are standard operational procedure for the An-10A.

All of the Aeroflot terminals now serviced by Tu-104 and Il-18 equipment have paved concrete runways with a minimum of 8,000 ft. Availability of this type runway will be a limiting factor in the speed and scope with which Aeroflot's jet services can be expanded. Aeroflot officials like to tell the story of how the Il-18 turboprop service came to Alma-Ata, the capital of the Kazakh Republic. The local government was so insistent on getting jet service that Aeroflot agreed to provide it if the Kazakh government would provide a suitable paved runway. The local government called for "volunteers" and built the runway with unpaid local labor working in their spare time. Aeroflot put the Il-18 into service nonstop from Moscow to Alma-Ata shortly after the runway was finished.

Foreign airlines are not all happy with the alternate airports provided for them by Aeroflot. On its Delhi-Moscow route, Air India uses Aktyubinsk and Alma-Ata as alternates for its regular stop at Tashkent. The standard alternates for western airlines serving Moscow via Copenhagen are Riga and Velikie-Luki which some airlines, notably British European Airways, find inadequate for its customary safety margins with Viscounts. Kubinka Airfield, a former military base west of Moscow, has been converted into an alternate for Vnukovo offering an 8,200 ft. paved runway.

Vnukovo already has added two wings to the original terminal building, one to handle expanding domestic passenger operations and the other for international traffic. Another sign of the changing times is the substitution of upholstered steel tubing chairs for the bare wooden benches that formerly filled the main Vnukovo waiting room. Two more office buildings (one nearing completion) are scheduled for construction at Vnukovo to house the expanding Aeroflot and foreign airline operations and traffic personnel. Aeroflot has completed a large new maintenance hangar at the far side of the field and is extending the other main runway to jet standards.

Airport terminal buildings at other fields visited appeared to be postwar structures with a surprising variety of architecture in view of the Soviet penchant for complete standardization of building with similar functions. They ranged from the tiny terminal at Sukhumi, barely large enough to house a small coffee shop and toilets, to the large, relatively new terminal at Tashkent, complete with souvenir counter selling Uzbek native craftwork, a large restaurant and the largest Intourist office we saw in the USSR.

Even in whistle stops in the Ukraine, the principal airport signs were in English and Russian. International flights are announced in both languages at Vnukovo and Tashkent. A standard feature of the smaller city airports is a portable stand in the main lobby at which razor blades, soap, brushes and combs and a sickly sweet perfume named Svetlana's Breath (named after Stalin's favorite daughter) are sold. Most airport restaurants also have a counter where champagne and chocolate are sold to take out. A snack bar where caviar, fish, salami and cheese sandwiches are available also is standard equipment.

Radar is the primary traffic control and approach system for Aeroflot operations. All major airports we visited, such as Vnukovo, Alma-Alta, Tashkent, Tbilisi, Sukhumi and Kiev, have World War II style VE beam radar installed for terminal area traffic control. These radars were all mounted on mobile military type trailers. Where elevation was required for terrain clearance, the radar trailers were mounted on high earth mounds.

In addition to the terminal traffic control radars, there are sufficient en route radar stations to provide continuous coverage, at least on all routes flown by international carriers and the main trans-Siberian route. Air India reports at least 15 radar stations available for position fixes on the Delhi-Moscow route with at least five reporting in English. Foreign pilots on the Copenhagen-Moscow run report quick course corrections received from

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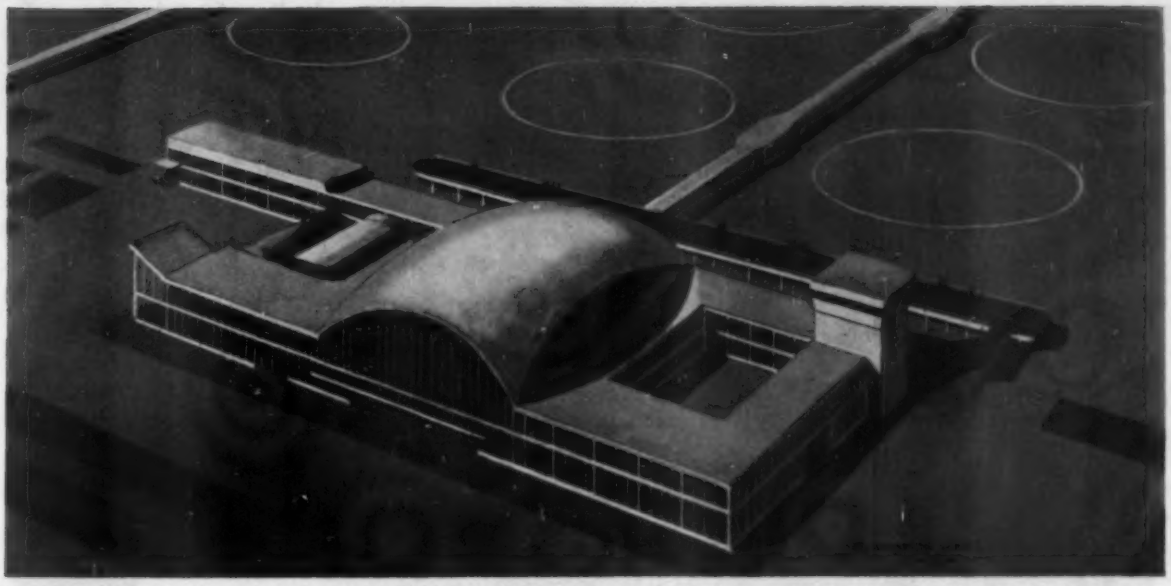

ARTIST'S SKETCH of new airport terminal building scheduled to be built at Kiev in current Seven Year Plan is typical of the new style terminals scheduled to replace older structures at major Aeroflot terminals. Control tower protrudes from right corner with long covered fingers providing protection from severe Russian weather for passengers to reach loading areas indicated by circles.

Russian ground radar stations en route when even minor course deviations are made.

GCA type equipment also is used at major terminals as the primary landing aid with a Russian ILS type beam landing system also available. GCA talkdowns in English are given foreign airline crews who request it at Vnukovo. All Aeroflot transports are equipped with ILS type cockpit cross pointer indicators with the indications reading exactly the opposite of western-type ILS. Aeroflot has purchased two western-type ILS installations in England (AW May 25, p. 29) for installation at Vnukovo and use by foreign airlines. The GCA equipment observed at Vnukovo and other airports appeared to be of early postwar vintage. Aeroflot officials say modern airport radar is being developed, including scopes remoted by television and modern traffic control center console displays combining a variety of radar-reported data. Communications are standard VHF type with single sideband equipment used on the newer jet transports such as the Il-18 and Tu-114.

Missile Installation

Non-directional radio beacons are the standard en route navigation facility. In flying into the Moscow area, both foreign airlines and Aeroflot piston powered transports follow a complex ground-directed approach pattern presumably to avoid too close an inspection of the triple belt of air defenses.

Despite this attempt at security screening, the standard approach from Velikie-Luki passes directly over one of the large chevron-shaped defensive missile installations in the Moscow outer missile belt. Aeroflot jet transports, apparently in the interest of fuel conservation, fly direct routes in and out that provide good visibility of both inner and outer belt missile installations and the ring of fighter strips that lies not far beyond the missile ring.

While returning to Vnukovo in an Il-14M from Kiev, our pilot flew a devious, twisting approach pattern apparently dictated by security considerations rather than traffic density but made his final approach to Vnukovo at relatively low altitude over the edge of the huge Red Air Force experimental flight test installation at Ramenskoye.

On other Aeroflot flights the low circling approaches and climb-outs after takeoff provided a good view of operational fighter and jet bomber fields, anti-aircraft gun parks and defensive missile batteries.

Ground Handling Equipment

Another major improvement is visible in the new crop of ground handling equipment used for jet transport operations at Vnukovo. The spread of this new equipment has not reached much beyond the Moscow hub and a few key international terminals such as Tashkent, but it is an indication of the Aeroflot trend in this field. Standard Soviet trucks have been quickly adapted to provide auxiliary power sources for parked jets and tow duty to haul the parked jets to hardstands far removed from the terminal area. Here engines are started both to reduce noise and blast effect in the passenger area and also to conserve fuel. Both turbojet and turboprop transports taxi back to the ramp after landing, under their own power.

The four-engine turboprops cut their two outboard engines to conserve fuel while taxiing in.

Hand-pushed baggage carts have been replaced by tractor towed trains of baggage carts and a conveyor belt baggage loader is now in service to feed the belly baggage compartments of the 100-passenger Tu-104B. Self-propelled adjustable height steps are used on all the jet transports.

Front and rear loading doors are used for simultaneous servicing and passenger loading operations of the Tu-104 and Il-18.

Modern Buses

Modern design passenger buses are now used on special service between downtown Aeroflot offices and the airports and to carry passengers from the terminal to departing aircraft. When passengers on the 55-min. Tu-104B service complained that the bus trip from Sverdlosk Square in Moscow to Vnukovo and from the Leningrad Airport to downtown took twice as long as the flight, Aeroflot quickly organized a special express bus service at both terminals that cuts the ground trip time in half.

(This is the third in a series of articles on Aeroflot, Soviet airline, jet operations based on interviews with Aeroflot officials in Moscow and on a 6,000 mi. trip around the Soviet Union flying in Il-18, Tu-104B and Il-14M transports.)

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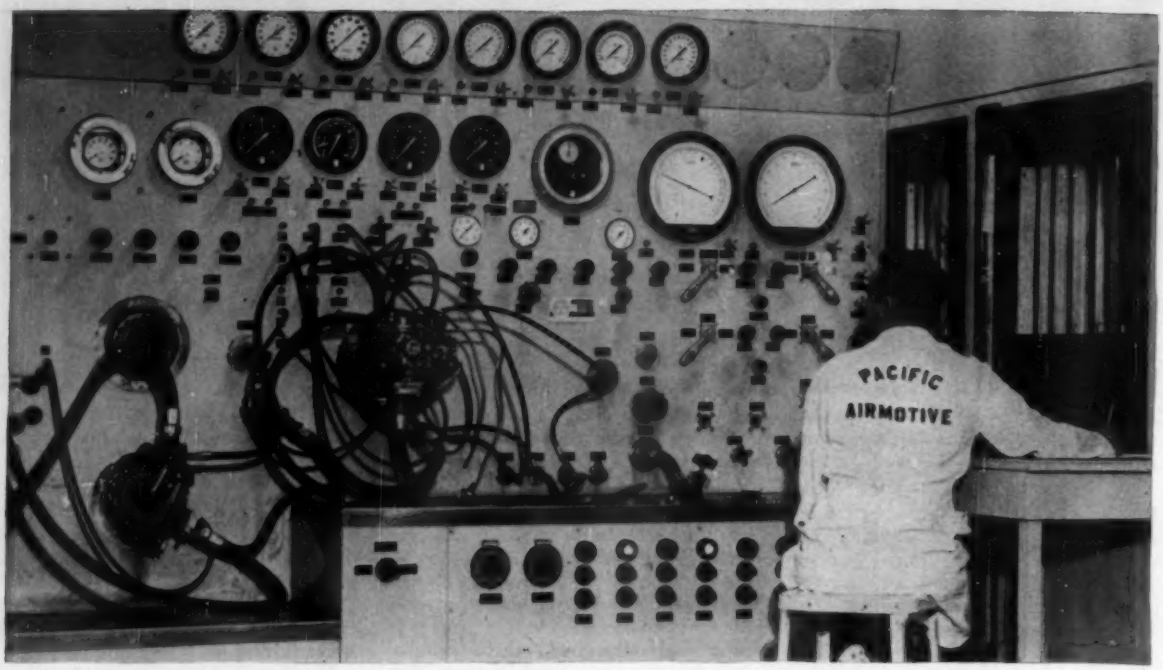
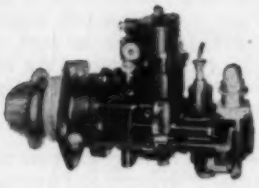
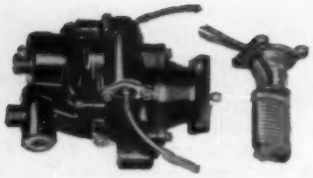
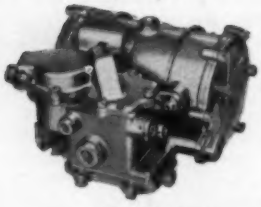




JT3 compressor bleed valve governor



JT4 compressor bleed governor



JT4 bleed valve actuator

JT3 compressor bleed valve & actuator

Fine Holley Carburetor Company jet fuel metering systems are cared for best at Pacific Airmotive Corporation on precise and elaborate test equipment such as the bench pictured above. Designed and built for PAC, this bench tests and calibrates jet fuel system accessories used on engines up to 30,000 pounds thrust.

PAC's veteran jet accessory mechanics have had extensive experience on Holley accessories such as the fuel controls for the T34, compressor bleed governors for the J57 and the J75 (JT3 and JT4), the bleed piston actuator for the J75, as well as many other fuel air, water and ignition accessories.

PAC's fully integrated jet accessory facility has two fuel control stands with fuel flow ranges to 64,000 pounds per hour, a fuel manifold stand, a bleed governor stand, and an electronic control stand. PAC's facilities at its main Burbank plant are completely up-to-date to test accessories for all engines used on current production jet aircraft. These facilities are constantly being expanded as new engines are developed.

Just as you can rely on Holley for fine jet fuel metering systems, you can rely on PAC for spare parts replacement, dependable testing and servicing of jet accessories.

HOLLEY Carburetor Co.

11955 E. Nine Mile Road Warren, Michigan

PAC

PACIFIC AIRMOTIVE CORPORATION

2940 N. Hollywood Way Burbank, California

SUBSIDIARIES: PacAero Engineering Corp., Santa Monica • Pacair, Inc. (International), Burbank • Pioneer Leasing Corp., Burbank

New Night-Coach Fare Protested by National

Washington — National Airlines moved last week to block a move by Northeast Airlines to offer reduced night-coach fares on a nightly basis, contending that Civil Aeronautics Board approval of the tariff would nullify the purpose of reduced night coach fares now being offered by National, Eastern and Northeast on the first four days of the week.

Requesting suspension and investigation of the Northeast tariff, scheduled to become effective Aug. 1, National said the proposal fails to meet CAB policy on off-peak service, will prove uneconomical for Northeast and will result in a return of traffic imbalance for all three carriers between midweek and weekend periods. As a defensive measure, the carrier noted, National and Eastern have both filed for the same fare reduction.

Much the same pattern evolved from National's filing, last March, of a 25% fare reduction for night coach flights on Monday, Tuesday and Wednesday (AW April 13, p. 39). Eastern and Northeast then filed defensive tariffs and asked CAB to suspend and investigate National's proposal. The Board dismissed their complaints and in July all three carriers extended the plan to include Thursday night coach flights.

Pointing out that it has been experiencing average load factors of 70.5% on Friday, Saturday and Sunday nights, as compared to 49.5% for other nights of the week, National said it assumes Northeast experiences much the same distribution of night coach traffic through the week. On the basis of these figures, National indicated that such weekend periods could not be interpreted as true off-peak periods under past CAB policy. Adoption of the Northeast tariff would result in a reversion of midweek coach passengers back to week-end travel so that the carriers "will be plagued with one of the very problems which the midweek fare was designed to overcome.

"Just as the Board originally required that off-peak fares apply only to truly off-peak periods, so also should the Board require that reduced off-peak fares apply only to such portions of the over-all off-peak period as require the application of such fares for promotional reasons," National said.

National also called attention to Northeast's original objection to the midweek tariff filing on grounds that it would be uneconomical: "It is most strange for a carrier, having asserted that a particular fare was uneconomical on a three night basis, to come in and initiate the application of the same fare on a seven night basis."

A True Story

The story you are about to read is true. A few names and numbers have been changed to protect the innocent.

It was Thursday, the 26th. I was working the morning DC-6 flight, Flight 274, out of Washington. My partner was Ben Fields.

• **8:21 a.m.** Flight 274 reports to the New York Center over the Columbus, N. J., intersection at 7,000 ft.

• **8:22 a.m.** Jet airliner, Flight 10, reports approaching Allentown, Pa., at 24,000 ft. with a minor fuel problem and requests an expeditious clearance to Idlewild.

• **8:24 a.m.** Jet Flight 10 reports over Allentown. The New York Center clears Jet 10 to descend to 18,000 ft.

• **8:25 a.m.** Flight 274 reports the ability to maintain visual flight conditions in order to allow Jet 10 an unrestricted descent.

• **8:27 a.m.** Jet 10 requests a direct steer toward Idlewild, an unrestricted descent and immediate priority landing clearance.

• **8:31 a.m.** Jet 10 arrives over Idlewild at 9,000 ft., lets down over the field and lands without further ado around 8:33 a.m.

Subsequent investigation disclosed that a faulty fuel quantity gage, plus the momentary flicker of a fuel warning light, had caused the cockpit consternation. The captain wisely chose a quick landing.

• **8:35 a.m.** Flight 274 reports to LaGuardia Approach Control over the Glen Cove, N. Y., marker at 5,000 ft. and is given a clearance to descend to 2,500 ft. on a north heading for a "back course" approach. This, if you remember the last LaGuardia accident, involving a Lockheed Electra, is known as the "unequipped" approach. Latest LaGuardia weather reports one mile visibility.

• **8:38 a.m.** As Flight 274 is descending through 3,000 ft., the LaGuardia controller is frantically calling "53 Papa"—requesting "Papa's" position.

• **8:39 a.m.** Flight 274 is requested to climb immediately to 3,500 ft., and make a 360 deg. turn on account of traffic "in your vicinity." (This is a frequent occurrence when VFR traffic arrives unannounced in the middle of instrument conditions.)

• **8:45 a.m.** Flight 274 is cleared for a back course approach behind 53 Papa.

• **8:48 a.m.** LaGuardia approach control requests 53 Papa to report his position. No answer.

• **8:49 a.m.** A second request brings forth the information that the direction finder shows 53 Papa is southeast of LaGuardia range and receiving "an erratic indication from the ILS localizer." (Flight 274, directly behind 53 Papa, has a normal indication. But one must remember that everything is backwards on a back course approach—the usual ILS sensing is reversed.)

• **8:50 a.m.** 53 Papa is told to climb immediately to 1,500 ft. on a northwest heading because the DC-6 (Flight 274) is also at 800 ft. approaching the LaGuardia range.

• **8:51 a.m.** Flight 274 lands at LaGuardia. 53 Papa is rerouted back for another approach after inbound traffic is reshuffled.

No criticism of 53 Papa's pilot is intended. Back course approaches, especially at places like LaGuardia, have no excuse for existence. Were we to trade Jet 10, with a real fuel problem (as they sometimes have), with Flight 274 a jolly mess would have been had by all.

These are the facts. Airports with 20-year-old facilities are hardly fit to serve multi-million dollar jet aircraft. This must be changed.

NAVIGATION AND GUIDANCE FOR MISSILES ▶

The management team of Nortronics Division of Northrop Corporation has more specific astro-inertial guidance experience than any other company in the free world. Here in one tightly knit organization are the men who created the state-of-the-art for airborne inertial guidance. The key management-scientist-engineer team who pioneered the Snark inertial navigation system in 1947 is still actively advancing the frontiers of this art. The most recent example of this is a breakthrough in 24-hour celestial tracking systems.

The list of accomplishments achieved over the past 13 years, if listed here, would more than fill this page. None of these achievements would have been possible without a dynamic, aggressive management group dedicated to producing the best product for the lowest cost – on schedule.

Missile scientists and engineers recognize Nortronics as a leader in the field of navigation and guidance. Nortronics' leadership has been accomplished by advanced research and development programs and years of production experience. These programs have resulted in state-of-the-art advancements in navigation systems which were considered visionary a short time ago.

Nortronics has today the solutions to tomorrow's missile guidance problems, the management and facilities to produce the systems required. The company's complete understanding of the military and technical requirements of missile systems qualifies Nortronics as the leading producer of tomorrow's most challenging astronertial guidance systems.

NORTRONICS
A Division of NORTHROP CORPORATION

Gear Bolt Failure Led to 707 Emergency

By Glenn Garrison

New York—The landing gear truck beam break which caused the loss on takeoff of two main wheels of a Pan American World Airways Boeing 707-120 jet transport (AW July 20, p. 34) was the last of a series of component failures on the particular landing gear involved, AVIATION WEEK has learned. All of the troubles were caused by failure of bolts which attach a snubber assembly to the truck beam and to the main landing gear strut.

No official report has been made on the beam failure, which is still under investigation by Civil Aeronautics Board and Federal Aviation Agency, but the break resulted from damage to the truck beam caused by its rubbing against the hydraulic strut of the gear. The snubber assembly is designed to absorb the pitching motion of the gear trucks and to arrest the travel of the truck beam upward toward the hydraulic strut. The snubber assembly had worked loose on several occasions previous to the July 11 incident which resulted in loss of the two wheels and a subsequent emergency landing at Idlewild with its attendant crowd problems.

There have also been isolated instances of similar snubber problems with other Boeing 707-120 aircraft. All airlines using the plane are now checking the beam for possible damage before each flight. One beam replacement has been made as a result of such inspection since the Pan American incident, but in this case the beam damage was considerably below what would normally be tolerable.

While the Pan American incident was being investigated, the 707-120 and New York International Airport hit the front pages again after an American Airlines jet reported hydraulic failure en route to the field and landed safely one week after the Pan American emergency. The resultant publicity led U. S. Rep. Steven B. Derounian (R.-N. Y.) to call for grounding of the airplane, but Federal Aviation Agency Administrator Elwood R. Quesada defended the 707 and said public reporting of the incidents "have taken them out of proportion to their seriousness."

The American jet landing was made at 6:04 p.m., about two hours after the pilot advised the airline by company radio that his hydraulic pressure gage was reading lower than normal. The Port of New York Authority was advised about 4:15 p.m. of the trouble, and when the pilot reported about 40 min. later that the hydraulic failure was complete, the Port Authority decided the situation called for help from the New York City Fire and Police Departments. The Port Authority notified these agencies and the tower, and cooperation was reported to have been satisfactory to all concerned, in contrast to the inter-agency conflicts of the Pan-Am case. City police set up road blocks at three airport entrances, screening traffic to prevent a recurrence of the previous Saturday's mob scene. A Port Authority spokesman said last week, however, that no police force could deal with a situation like that of July 11.

The American incident actually was one of 50 jet alerts at the airport that have occurred since last October. During the past year, according to Port Authority figures, there have been 1,000 alerts of both piston and jet aircraft. In each alert, Port Authority emergency equipment is dispatched to the runway. The jet alerts have resulted from troubles with hydraulic systems, engine flameouts, oil leaks, flat tires, pump failures and other bugs, according to the agency. But most of them were not considered serious enough for Fire Department aid to be requested.

One of these alerts, incidentally, was another American Airlines jet that landed while the damaged Pan American plane was still circling the airport July 11 and burning off fuel for its landing. The American Airlines plane, also with hydraulic problems, landed unnoticed in the general confusion. The Port Authority took two emergency trucks off the runway where the PanAm plane was to land and sent them quietly over to another runway to stand by for the American jet.

In the July 18 American Airlines incident, the gear was lowered by the manual system. Part of Boeing's "fail-safe" principle of backup systems, this involves use of a special wrench which opens the gear doors with a few turns, unlocks the gear and allows it to fall into landing position. A few more turns of the wrench lock the gear down. There are two backup braking systems in addition to the thrust reverser on each engine.

American is still trying to nail down a general problem with the hydraulic system of its jets. According to the airline, the problem is that of excessive pressure buildup which causes some part of the system, such as a seal or pump valve, to fail. In the latest case, American believes a faulty filter may have caused the trouble.

Quesada, who discussed the American and Pan American incidents in a telegram to Rep. Derounian last week, said the American hydraulic failure "has been localized to improper installation of a hydraulic seal and does not . . . reflect adversely on the aircraft's design."

The FAA chief advised Derounian that the 707's fail-safe design reduces such defects as hydraulic failures "to the category of a nuisance rather than a recurring safety problem." Quesada said the PanAm incident was a structural failure "traceable to a series of mechanical difficulties immediately preceding the failure." FAA had re-evaluated the certification process used on the 707's landing gear, Quesada reported, and "nothing to date has been found to indicate that the design and fabrication of Boeing 707 landing gears is deficient."

Slick Airways Orders Electra and Hercules

Washington—Slick Airways' orders for six Lockheed Electras and six Lockheed Super Hercules turboprop air freighters highlighted exhibits filed by the cargo carrier last week in the Domestic Cargo Mail Service Case.

Asking the Civil Aeronautics Board for permanent cargo and mail certification and subsidy eligibility, Slick said it expects to resume common carrier air freight operations by early next year and plans to have the Electras in service by 1961 and the Super Hercules operating by the middle of 1962. Slick suspended service in February, 1958.

Resuming common carriage next year with a fleet of eight Douglas DC-6A aircraft will leave the company with a net loss of $993,000 for the year, based on an expected average load factor of 70% and a yield of 18 cents per revenue ton mile. Slick estimates that application of the 10.25% rate of return on investment, recommended for the Big Four carriers by a CAB examiner in the General Passenger Fare Case, would result in $1,900,000 in subsidy payments for Slick in 1960.

Use of Electras in the second phase of its resumption of operations would yield the cargo line a net profit of $702,000, on a 70% load factor and average daily utilization rate of 7.1 hr., but would still require subsidy totaling $1,048,000 because of the increased investment of $16 million for new equipment.

Slick said it signed letters of intent on July 15 for the purchase of both Electras and Super Hercules, with a proviso on the Electra agreement that purchase depends on leasing the aircraft to other operators by the end of 1962. Company spokesmen said a leasing arrangement is already firm, but declined to identify the operator.

AIRLINE OBSERVER

► United Air Lines' two Douglas DC-8s now being flown in Denver for crew training are falling short of their speed specifications. Fix will consist primarily of added wing area at tips, more fuel and installation of vortex generators at strategic points of the wing. Meanwhile, United also has pulled some seats from the aircraft to extend training flying time between refueling stages.

► **Three South American carriers have pooled their equipment to permit the operation of a no-reservation service between Rio de Janeiro and Sao Paulo. The carriers—Varig, VASP and Cruzeior do Sul—operate flights between the two cities every half-hour. If the plane is filled or is missed, passengers wait a half-hour for the next flight.**

► Watch for an expansion of in-flight ticketing procedures on long-range flights. Plan was first introduced by Continental Airlines (AW June 15, p. 38). Western Air Lines will adopt a similar system on some of its Lockheed Electra flights.

► **American Airlines' conversion of 10 Douglas DC-7s to all-cargo aircraft will be an interim measure. The planes will be replaced by turbine-powered aircraft when "suitable" planes are available. Here is what American wants in an all-cargo airplane, according to the company's vice president-equipment research William Littlewood: turbofan power with direct operating costs no higher than four cents per mile and coast-to-coast nonstop capability at a maximum cruising speed of 600 mph. Lift should be in the 40-50,000 lb. and 80-100,000 lb. ranges. Mechanized loading systems should be designed as an integral part of the aircraft.**

► Move to bring about lower fares on transatlantic routes is gaining momentum in Britain (see p. 33). One group of British aviation leaders is advocating an immediate reduction of present air fares by one-half, adding that one-way passenger fares could be cut to $85 within 10 years.

► **Volume of coach available seat miles offered by the domestic trunkline industry in June continued to climb at a faster clip than the total of first-class available seat miles. During the month, coach available seat miles represented about 41% of the total 3.84 billion available seat miles offered by the 12 trunklines.**

► Chances are now strong that the International Air Transport Assn. Traffic Conference, which begins Sept. 14 in Honolulu, will not adjourn this year before the IATA general meeting convenes in Tokyo Oct. 12 because of the number of highly controversial rate and fare issues facing the conference (AW July 20, p. 47).

► **Continental Airlines will show a revenue passenger mile gain of as much as 75% in July over the same month of last year. August traffic increases are expected to be even more spectacular with the introduction of Chicago-Kansas City-Denver-Los Angeles turbojet service on Aug. 15. The airline showed a 61% gain in revenue passenger miles in June over the previous June. Third Boeing 707 turbojet transport has been delivered, and the fourth and final aircraft of the current order is slated for delivery next month. Utilization rate on the Boeing 707s is running at 11 hr. 30 min.**

► Mohawk Airlines has purchased four new Convair 440 transports from the Convair Division of General Dynamics Corp. First of the new planes will go into scheduled service about Aug. 15.

► **Federal Aviation Agency has purchased seven scan conversion units to bring to 54 the number of units purchased for installation in control towers and air route traffic control centers.**

► Contracts totaling $1.6 million have been let by Federal Aviation Agency for research on air traffic. Companies winning contracts are: Applied Psychology Corp.; General Precision Laboratory; Airborne Instruments Laboratory; J. W. Fecker, Inc.; Lear, Inc.; Arinc Research Corp.; Systems Development Corp.; Servo Corp. of America; Stromberg-Carlson and Cornell Aeronautical Laboratory.

SHORTLINES

► **American Airlines** reports net earnings of $9,105,000 for the second quarter, compared with $5,567,000 for the same period in 1958. Total revenues for the three months rose 18% over last year to $97,431,000. First half net earnings after taxes amounted to $8,827,000, bringing per share earnings to $1.07 from 88 cents earned for the first half of 1958. American flew a total of 2,515,505,000 revenue passenger miles, a 2% increase, and 46,091,000 freight ton-miles, a 7% gain, during the first half.

► **Chicago Helicopter Airways** carried 20,112 passengers during June, a 122% increase over June, 1958. Load factor for June was 60%, compared with 36% in a comparable period last year.

► **City of Genoa**, Italy, has approved an added expense of $5 million to extend the main runway of the city's new airport now under construction. The cost represents a 1,590 ft. extension.

► **Civil Aeronautics Board** may be dialed after Aug. 2 by using the exchange DUdley 2 followed by the present extension number listed on Board reference sheets. The exchange EXecutive 3-3111 may still be used.

► **International Air Transport Assn.** reports member airlines carried a total of 69,249,000 passengers during 1958, a 7.3% increase over 1957. Cargo traffic rose 21.5% and mail traffic rose 10.3% over last year.

► **Mohawk Airlines** carried 51,808 passengers 9,980,000 revenue passenger miles in June, increases of 29.1 and 32.3% respectively over the previous June. The local carrier had its best single day on June 19 when it carried 2,283 passengers on its routes.

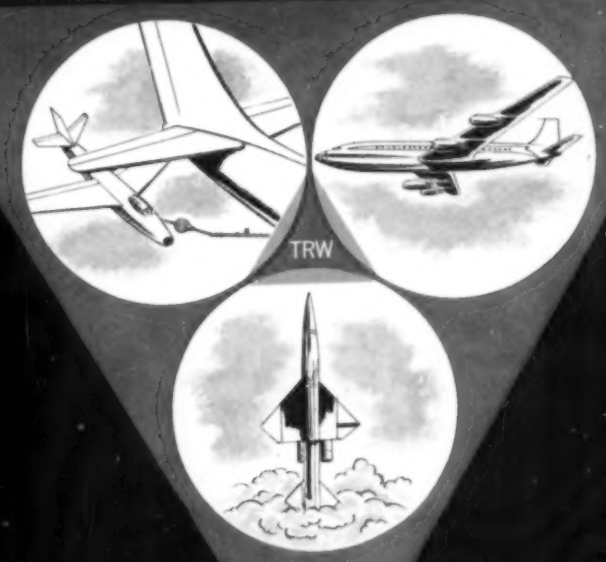
► **REAL and TSA-Transcontinental** S. A. will discontinue their combined sales pool effective Sept. 4, and each carrier will concentrate on developing the flow of traffic through its respective U. S. gateway. Normal relations between the two airlines will continue through International Air Transport Assn.-type interline agreement.

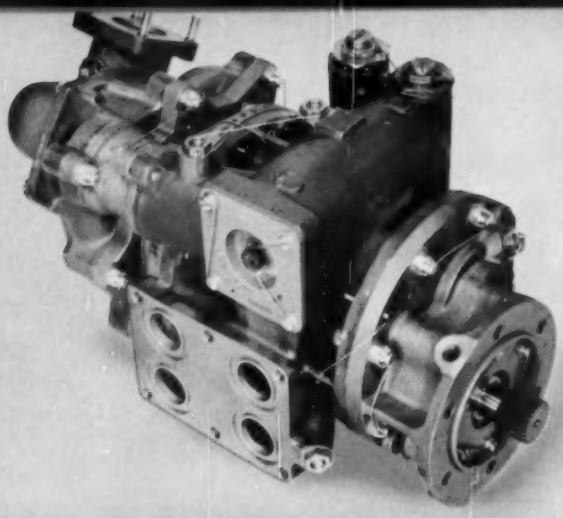
► **Western Air Lines** board of directors has declared a regular cash dividend of 20 cents per share, payable on Aug. 14, 1959 to shareholders of record on Aug. 3. At the director's meeting, the board was told the airline's June operating revenues were an estimated $5.3 million and that the carrier had operated 84.3 million revenue passenger miles during the month.

AT THE

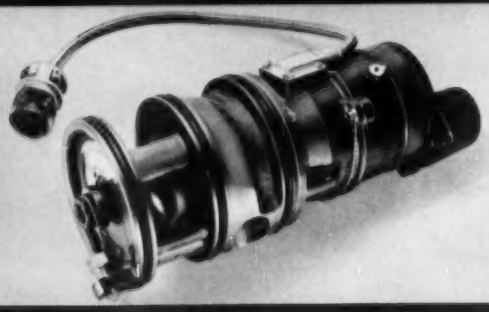
TAPCO GROUP...

Development
and production of fuel
systems and components

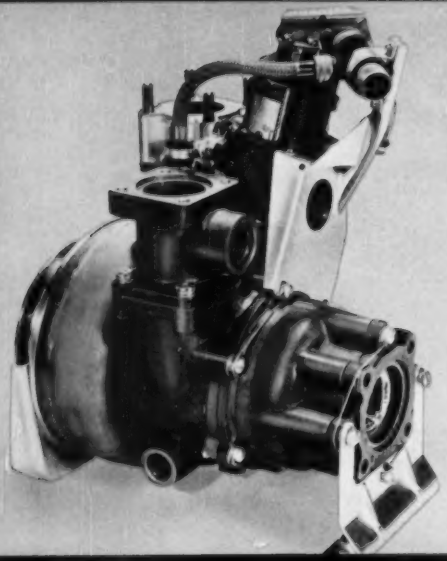




TAPCO designed and produced engine-driven combination main-and-afterburner fuel pump now providing thousands of hours of trouble-free service in several current models of production fighter aircraft.



Turbine-type electric motor driven water-injection booster pump designed and produced by TAPCO for a major American jet engine. Unit is easy removal for routine inspection without draining fuel tanks.



This turbine-driven water injection thrust-augmentation pump and controls combines three TAPCO Group capabilities: the experience and facilities to design, produce, and test the pump, electronic controls and turbine entirely within the TAPCO organization.

FROM THE TAPCO GROUP...

Pumps, Controls, and Accessories to handle any fuel, any fuel situation

Over 1,100,000 pumps delivered... twenty years of experience that began in 1939... 10,000 people... 3,000,000 square feet of research and production area ... these are some of the reasons the TAPCO Group is the leading developer and manufacturer of all types of aircraft and missile pumps, controls, fuel valves, and turbine-driven pumps and accessories.

TAPCO pumps have been developed to meet severest conditions of altitude, rate of climb, pressure, attitude, G-factors, and fuel chemistry. TAPCO-designed models include vane- and gear-type main engine fuel pumps, fuel transfer and vapor separating booster pumps, thrust-augmentation pumps, turbo-pumps, combination main-and-afterburner pumps.

New TAPCO impeller designs, improved seals and internal passages give TAPCO pumps maximum efficiency and the ability to perform dependably under severest flight and temperature conditions, while pumping any of the approved liquid fuels and supplements. A feature of TAPCO booster pumps is high vapor-elimination capability, which eliminates vapor-lock in the fuel system.

Other fuel-system components and accessories developed in producing homogeneous, single-source TAPCO fuel systems include control valves, air turbine drives for pumps, quick-disconnect couplings, flow-equalizer valves, and in-flight refueling systems.

For your aircraft or missile contract, let us supply you with a *complete fuel system* designed, built, and fully service-tested by the leader and largest manufacturer of fuel pumps and systems... the TAPCO Group.

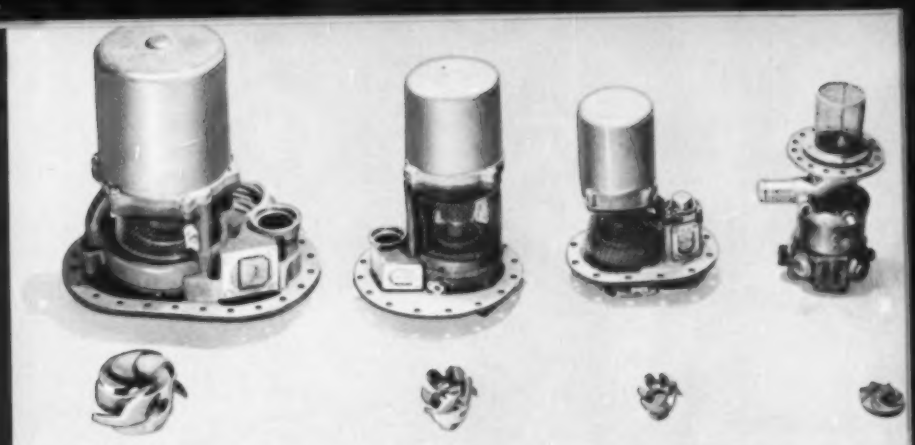
TRW

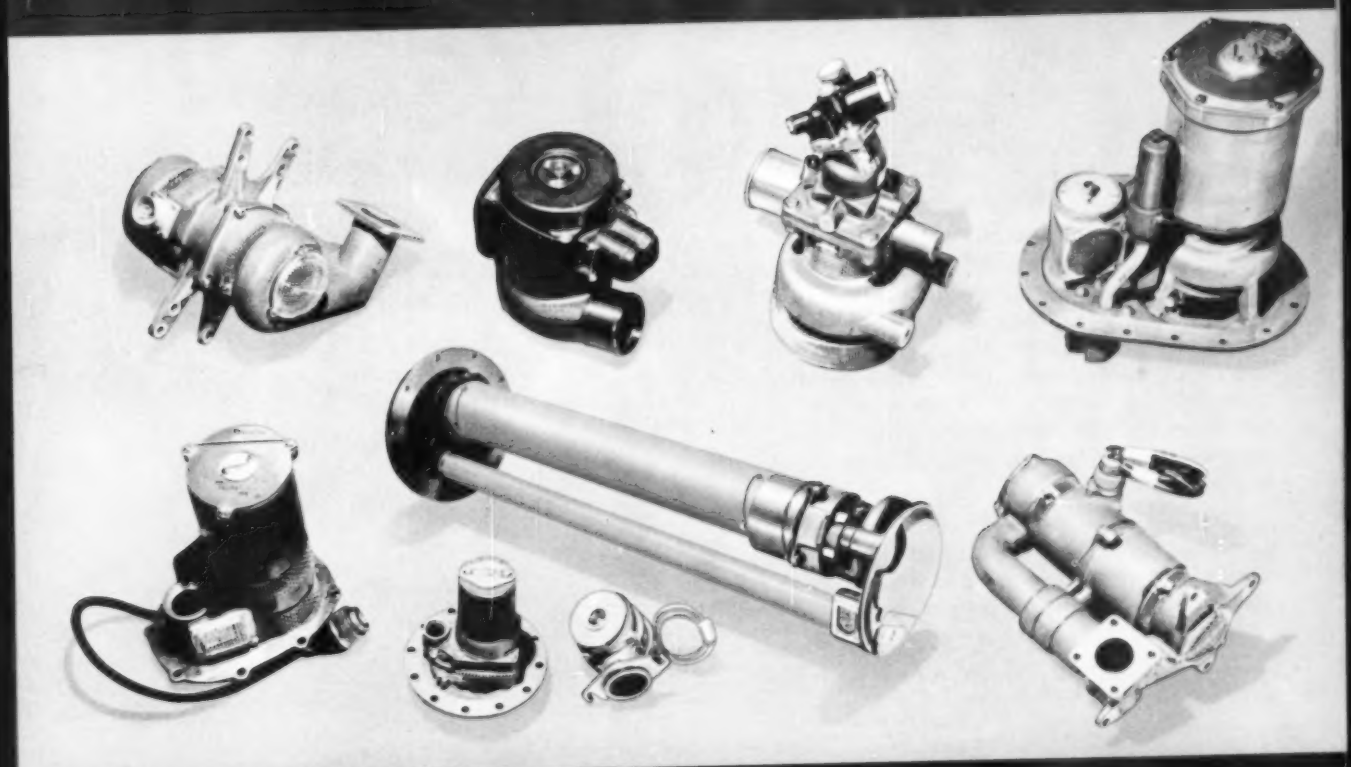
TAPCO GROUP

Thompson Ramo Wooldridge Inc.

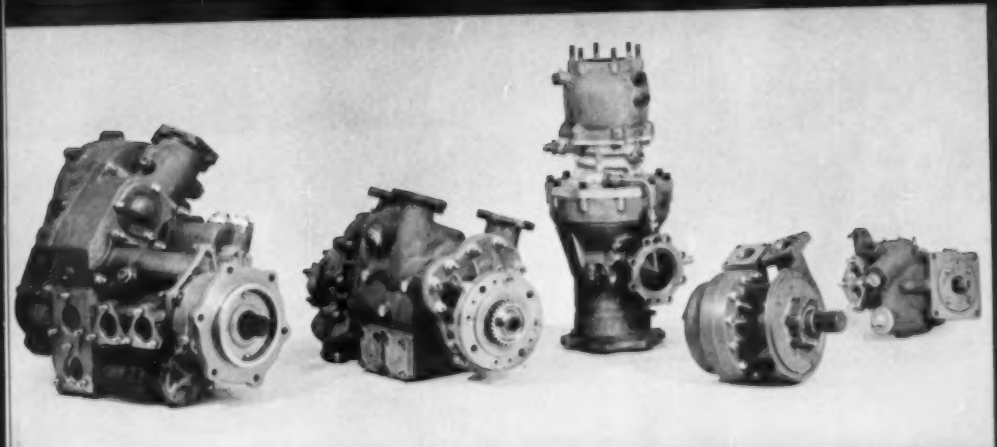
CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

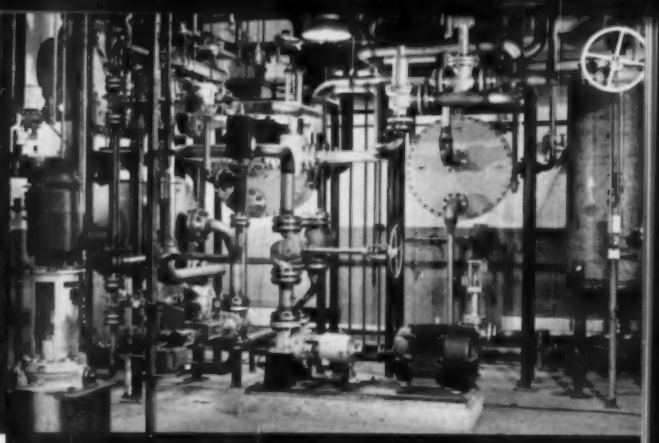




The broad variety of booster pumps now in production at TAPCO includes these AC electric and hydraulic motor-driven units for helicopters and small aircraft, as well as special designs for unusual negative G conditions for high performance fighter aircraft. Capacities range from 2 gpm to 250 gpm.



at THE TAPCO GROUP...
Complete research and test facilities... plus supporting services



Hot-fuel test lab at TAPCO, shown only in part here, can test fuel pumps under ambient temperature conditions as high as 750° F, circulating up to 500 gpm of fuel at 550° F at 1500 psi. Pump-driver speeds up to 28,000 rpm are available. These conditions can be cycled for high Mach number flight schedules.

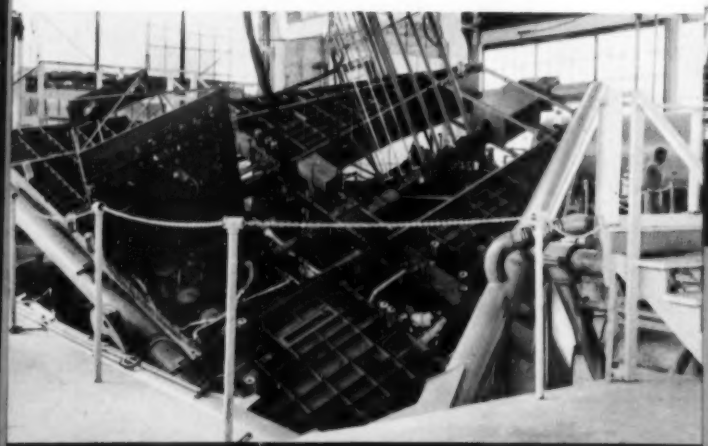
For over 20 years, the development of new fuel system principles and the design of pumps and components to utilize these principles have been a major area of investigation for the TAPCO Group research department. Just as the seemingly insurmountable problem of getting cargo aircraft over the Himalaya mountains was solved by TAPCO-pioneered booster pumps during World War II, TAPCO continues to pioneer the state of the art in fuel system development.

Today, more than 1000 experienced men and women using 7 TAPCO fuel labs are investigating and developing techniques to power tomorrow's flight vehicles of all types. They have worked with high energy fuels such as boron, slurries and monopropellant fuels such as ethylene oxide, UDMH and normal propylnitrate. Extensive work has been done with anhydrous hydrazine. Experience is being accumulated with the new fuels for advanced spacecraft, such as liquid hydrogen.

To assure proper support for fuel system and component contracts, a highly-skilled field service organization is maintained, and spare parts singly or in kits are available to meet your requirements.

Let us have a TAPCO Group sales engineer discuss *complete* fuel systems, pumps, controls, and valves with you soon.

Complete missile fuel system mockup at a TAPCO laboratory simulates missile flight conditions for pre-flight checkout of the fuel system.



High performance fighter aircraft fuel system simulated by this complete mockup at another TAPCO facility saved hundreds of expensive flight test hours.

TAPCO GROUP

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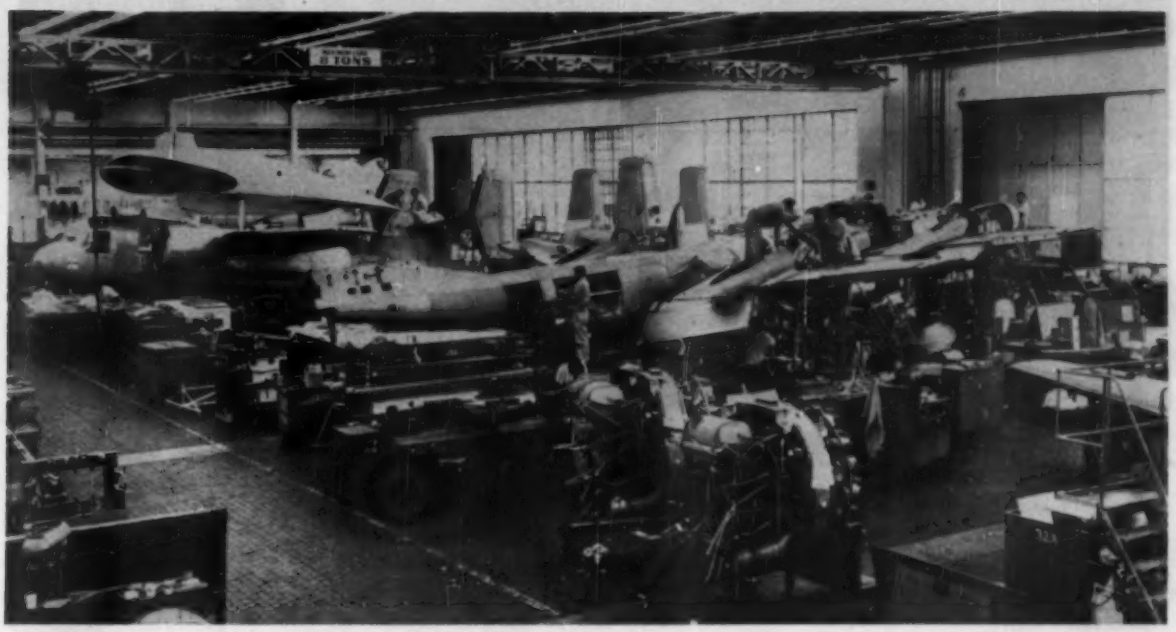

PREPRODUCTION YAO-1 Mohawk numbers one (right background) and two (center) take shape at Grumman's Bethpage plant. The number two aircraft is shown about two weeks prior to rollout. Aircraft visible in right background include a WF-2 early warning aircraft and an S2F-3 anti-submarine warfare plane. Grumman has begun tooling for the 35 AO-1s to be built starting January, 1960.

Mohawk Shows Good STOL Capability

By Barry Tully

Bethpage, N. Y.—First Army turboprop aircraft, the Grumman YAO-1 Mohawk tactical observation plane, demonstrated good short field and low altitude performance at the company's Peconic River facility.

The two-place twin-engine aircraft, intended for rough field operation, will carry aerial cameras, side-looking radar or infrared mapping equipment for its tactical observation mission.

The aircraft was flown from a taxiway by Grumman test pilot Ralph Donnell to demonstrate short-field takeoff, high-speed and single-engine flyovers, slow-flight and a short-field landing.

Turning Radius

The twin-turboprop aircraft demonstrated its extremely small turning radius and, with wing slats and flaps extended, showed its ability to "hold" over a ground position by flying a tight figure eight pattern.

The short landing capability of the Mohawk, which touches down at 55 kt., is enhanced by reversible pitch propellers fitted to the Lycoming T53-L-3 turbine engines. By applying full reverse pitch power upon touchdown, and vigorously braking, Donnell brought the 11,000-lb. aircraft to a stop in approximately 300 ft.

Although the prototype aircraft does not contain any surveillance equipment, Grumman says the flight test instrumentation weighs more than its operational equipment. Empty weight of the aircraft is 8,000 lb.

The two aircraft now flying are the first of nine YAO-1s that Grumman is building for the Army under a $22 million contract. The last YAO-1 model is slated for completion in De-

MOHAWK takes off with 25 deg. flap setting. When flaps are extended, the section outboard of the engine nacelles acts in conjunction with the ailerons for increased lateral stability at low speeds. The aircraft is intended for rough field operation.

Increased Production Facilities for Cannon MS Series Plugs

MODERN PRODUCTION FACILITIES—The new modern Cannon factory building in Santa Ana has over 110,000 square feet of floor space, equipped with the latest automatic and semi-automatic processes. This increased production capability has been organized especially for the production of the Cannon MS line of plugs.
QUALITY CONTROL—The Santa Ana Division utilizes the most modern methods of quality control to insure conformance to MIL-Q-5923, MIL-C-5015, and related specifications as presented in the latest QPL Lists.

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A complete engineering staff is maintained at Santa Ana to handle all special modification requirements on the MS Series, and to serve customers with unusual needs.
FASTER DELIVERY—This new facility further increases the ability of Cannon Electric Company to provide fast deliveries of Cannon Plugs, without sacrificing quality or reliability.
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All Cannon MS Series Plugs conform to Military Specification MIL-C-5015D (ASG)

CLASS R — environmental resisting (Lightweight) Cannon Plugs are a new addition to the MS Line. Class R Plugs are intended for use where the plug will be subject to heavy condensation, rapid changes in temperature or pressure, and to high vibrations.

Cannon is the only qualified source for the complete line of the new Class MS-R Plugs. MIL-C-5015D specifies that Class R Plugs shall have the "wire sealing grommets in firm contact against the rear face of the insert." This requirement, now written into the specification, has always been a Cannon design criterion for all MS environmental resistant designs.

MS — MS-A, MS-B, MS-E
■ 260 Shell Styles ■ Lightweight ■ 1 to 100 Contacts ■ 15 different Diameters
All Cannon MS Plugs Conform to Military Specification MIL-C-5015D (ASG)

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CANNON PLUGS

Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo. Distributors and Representatives in the principal cities of the world.

ARMY markings and olive drab color of number two YAO-1 are for purposes of aircraft demonstration. The aircraft will be repainted in high visibility red and white test colors. Semi-planform view accentuates large plastic canopy and aircraft's 5.3 aspect ratio wing.

cember, after which Grumman will begin production of 35 AO-1 aircraft under a second $22 million Army contract. The program is being administered for the Army by the Navy's Bureau of Aeronautics.

Conceived as a joint Army-Marine aircraft, the Mohawk is now being developed solely for the Army. The departure of the Marines from the project, a move dictated by Defense Department economy measures, has influenced the design of the aircraft. One change was the dropping of a water-ski landing gear which would enable the aircraft to land on the water and taxi to a beach at a minimum speed of 20 kt. (AW Mar. 3, 1958, p. 83). The Army decided that it did not need this capability, so it was dropped in favor of a less complicated snow-mud ski. This ski has a drag penalty of 6 kt. when retracted.

Design Distinction

Another design distinction between Marine Corps and Army aircraft is that the Marines are permitted the use of tactical ground support aircraft whereas the Army is not. This means that since the Marine Corps is now out of the project, anything that looks like a bomb rack or rocket rail on the aircraft is likely to draw fire from other branches of the Defense Department for usurping another service's mission. The aircraft, incidentally, does exceed the 5,000 lb. weight limitation imposed upon Army aircraft as does the 26,000 lb. de Havilland Caribou.

During the design stage of the aircraft the empennage was changed from a T-tail to the present three fin configuration. Wind tunnel tests indicated a lack of single-engine control with the single fin and rudder. The asymmetric thrust forces could have been controlled with a hydraulically-boosted single-engine rudder assist which increases rudder area, but the company wanted to avoid this if possible.

Wind Tunnel

Wind tunnel investigation of a twin-tail design found that it restored single-engine control at the expense of directional stability which was lost due to propwash effects. The addition of a third fin and rudder proved to be the answer to both problems, and still maintain manual control.

Grumman, in designing a STOL aircraft, came up with a 5.3 aspect ratio wing, large flap area and wing slats. The hydraulically-actuated slats work in conjunction with the flaps. The flaps have three positions: up; 25 deg. down for takeoff and 45 deg. down for land-

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Body Assembly, Ferrule Clamp
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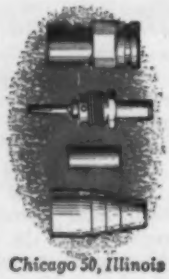

AMPHENOL CONNECTOR DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION *Chicago 50, Illinois*

AO-1 Specifications

Wing span	42 ft.
Over-all length	41 ft.
Tail height	12 ft. 8 in.
Wing area	330 sq. ft.
Aspect ratio	5.35
Takeoff gross weight	10,423 lb.
Empty weight	8,000 lb.
Powerplant (2)	Lycoming T53-L-3
Takeoff power	1,005 eshp. each
Maximum speed at 5,000 ft., military power, level flight	275 kt.
Stall speed, landing configuration, power on	55 kt.
Single engine control speed	64 kt.
Service ceiling	32,500 ft.
Rate of climb	3,000 fpm.
Rate of climb, single engine	1,050 fpm.
Endurance at 200 kt., 5,000 ft.	2 hr.

ing. The propeller diameters cover about 50% of the total wing span.

Increased lateral stability with the flaps down was provided by making the flaps outboard of the engines serve as auxiliary ailerons. These flaps, called inboard ailerons, do not extend more than 25 deg. The inboard ailerons move through 50 deg. of arc from 25 deg. down at neutral aileron to 25 deg. up at full up aileron. These inboard ailerons are the only hydraulically-boosted control surfaces on the aircraft. Other flight controls, including trim tabs, are manually operated.

Speed Brakes

In addition to flaps and wing slats, the YAO-1 is fitted with hydraulically-actuated speed brakes which extend from the sides of the fuselage. The speed brakes will permit the aircraft to plummet from its economical cruise altitude of 25,000 ft. to tree top level. This maneuver will be the Mohawk's most effective evasive action in the event of attack by enemy fighters.

The straight and level top speed of the Mohawk will be approximately 275 kt. and the designed service ceiling is 32,000 ft. Structurally the aircraft can withstand positive 5g up to its design limit speed of 390 kt. Rolling pullups are limited to 4g. The flight-test program has not progressed to the point where any maximum limits can be tested, but preliminary results are quite promising.

Design stall speed of the AO-1 is 63 kt. power off and 55 kt. at 10% normal rated power both at landing weight of 9,423 lb. Flight experience indicates that these speeds are on the high side.

Grumman guaranteed takeoff over a 50-ft. obstacle at 10,423 lb. gross weight and 64 kt. single-engine control speed in a distance of 655 ft. Landing over a 50 ft. obstacle at 9,423 lb. gross weight is guaranteed to be within 776

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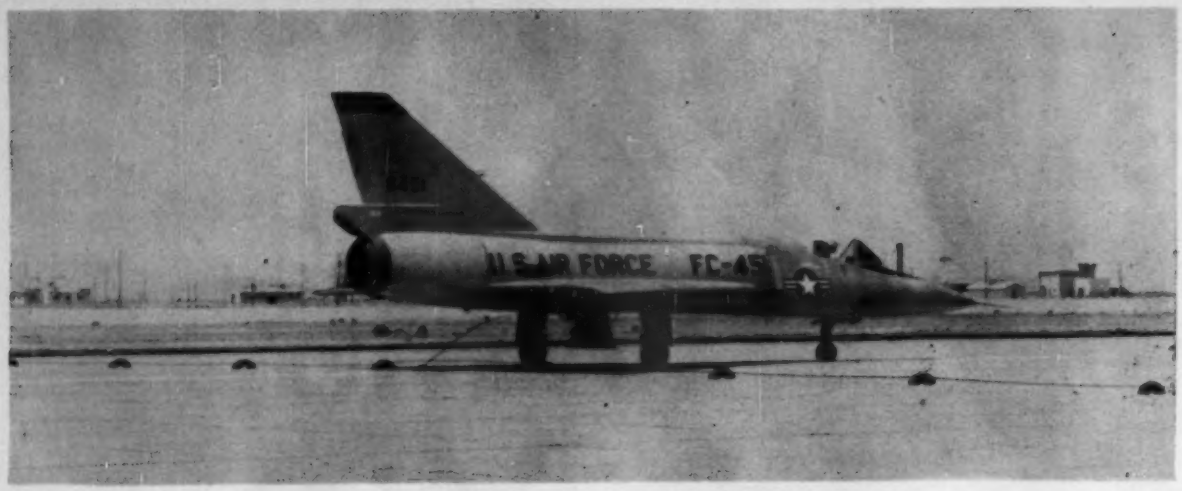

Convair F-106 Equipped With Tail Hook

All American Engineering Co. will produce tail hooks for U. S. Air Force Convair F-106 jet fighter interceptors, following successful prototype tests (above) at Edwards AFB, Calif. Hook engages a runway cable and anchor chain barrier at 110 kt. Hook, invented by company engineer Bruce Sheaffer, weighs 35 lb. and is made of spring steel, secured to underside of the jet and held flush under tension. Pilot energizes an electrical circuit and hook springs into the lowered position for engagement. Application of the principle for use on commercial jet transports now is under evaluation at Federal Aviation Agency's experimental center at Pomona, N. J.

ft. Again performance of YAO-1 numbers one and two indicate that these estimates are conservative. The guaranteed cruise of the Mohawk is 2 hr. at 200 kt.

The Lycoming T53-L-3 turbine which powers the Mohawk is rated at 1,005 eshp. This power range is more suitable for helicopter application, for which the T53 was chiefly intended, rather than for military aircraft, but the engine suited the AO-1 design well. Selection of the T53 for the Mohawk, the engine's only fixed-wing application, resulted in a $7.6 million production contract for Lycoming.

Engine Details

Grumman engineers have, thus far, been pleased with the engine's performance and reliability. The T53-L-3 is a single-stage free-type power turbine with an axial-centrifugal compressor driven by a single-stage turbine and an external annular vaporizing combustor. The turbine develops 960 shp. and approximately 100 lb. of jet thrust on takeoff at a gas producer speed of 26,390 rpm. and a prop shaft speed of 1,678 rpm. Gear ratio between the power turbine and propeller drive is 12.46:1.

Engine anti-icing is accomplished by passing hot compressor bleed air through the engine inlet struts and inlet guide vanes. The three-bladed Hamilton Standard Hydromatic propeller is full-feathering and has reversible pitch. Prop swath diameter is 10 ft. The complete engine and propeller powerplant package is interchangeable between the left and right wings.

The YAO-1 prototype aircraft are built with two methods of starting engines—the primary one a connection for attaching an air hose from a ground turbine, and an electric starter-generator for inflight starts. In practice, however, the starter-generator powered by a 24 v. nickel-cadmium battery proved so effective that the production AO-1s will be built without the air hose fitting.

The cockpit is designed to provide maximum visibility forward and downward. Seating is side-by-side and engine controls are mounted on a center pedestal. The AO-1 is fitted with a control stick and rudder pedals on the left side only. However, control linkage and a stick socket are located on the right side so that the aircraft can be quickly converted to a dual-control aircraft for training or checkout purposes. In operational aircraft, location of surveillance scopes on the right side necessitates removal of the control stick. Dual instrumentation also is available for training.

The aircraft is fitted with rocket-propelled Martin-Baker ejection seats capable of safely ejecting personnel from 60 kt. to the Mohawk's maximum airspeed. Seat is fitted with automatic deployment and seat separation devices.

Ejection seats are dictated by both the low-altitude tactical flying for which the aircraft was planned and the engine location aft of the cockpit which makes a conventional bailout with the engines running virtually impossible.

Normal ejection in the Mohawk is right through the overhead canopy. The canopy can be jettisoned pneumatically, but it is not part of the firing sequence. Grumman demonstrated the effectiveness of this manner of ejection by ejecting anthromorphic dummies through a Mohawk canopy at the Navy Air Crew Equipment Laboratory, Philadelphia, Pa. Grumman says this method is safer than blowing off the canopy because if the canopy jammed and was only partially blown off, the pilot's head might contact a structural bow on the canopy, which would cause fatal injury.

The crew of the Mohawk is protected from ground fire by ¼-in. armor plate floor and removable flak curtains fore and aft in the cockpit. The plastic windshield is 1 in. thick. Total armor protection on the plane weighs 372 lb.

Production AO-1s will carry either side-looking radar (SLAR) or infrared mapping equipment. The side-looking radar, designed and produced by Motorola, Inc., will be carried externally on an 18-ft.-long cylinder mounted on the lower right side of the fuselage.

Mapping Equipment

Infrared mapping equipment, supplied by Haller, Raymond & Brown of the Singer Military Products Division, is carried internally. The two surveillance equipments can be interchanged between planes, but cannot be carried by one aircraft.

The Mohawk's aerial camera will be a standard KA-30 camera supplied by Chicago Aerial Industries, Inc., with controls by Topp Industries. The camera is located in the fuselage beneath the wing and can be rotated 15 or 30 deg. left or right oblique from the cockpit. Night photography can be accomplished with upward-ejecting flares carried by the aircraft. Two flare

pods can be carried on either side of the fuselage at the trailing edge of the wing with 52 flares installed in each.

Navigation equipment includes an electronic doppler navigation system being produced by Ryan for the AO-1 project under a $3.5 million contract. The Ryan 120A navigator displays ground speed and drift angle on an indicator and can supply electrical outputs of this data to mapping equipment. Other navigational equipment that will be standard on the aircraft is Tacan, automatic direction finder and IFF.

Fuel for the Mohawk is carried in one self-sealing fuel tank located in the fuselage over the wing. Tank capacity is 276 gal.; however, two Douglas 150-gal. drop tanks can be carried on the wings. Fueling is accomplished either by 3-in. filler caps in the tanks or by single point pressure fueling. Pilot and shutoff valves in the main tank control the flow of fuel from the wing tanks. When the transfer switch is on, the main tank remains full until both drop tanks are empty.

Fuel pressure is maintained by two boost pumps which charge a main fuel line feeding both engines. Grumman says both pumps are necessary to supply pressure in all attitudes; however, one pump will keep the aircraft flying.

The aircraft electrical system is 28 v.d.c. with two parallel connected 300-amp. starter-generators. The battery is a 24-v., 36-amp. hr. nickel-cadmium type. Either generator is capable of handling the electrical load. Alternating current is supplied by two inverters which furnish 115/200 v., 400 cps., a.c. power.

Grumman, in keeping with the combat area deployment of the aircraft, has attempted to design maximum serviceability and maintenance into the Mohawk. The avionic compartments of the plane are accessible through latched doors on the fuselage within easy reach of a man standing on the ground. The main fuel cell can be readily replaced by removing two panels on the upper fuselage.

In addition to providing ease of access, Grumman has designed all major assemblies to be interchangeable. Powerplant packages will fit left or right wings. Major landing gear components, stabilizer, elevator and outboard fins and rudders are interchangeable left and right.

The complete wing panel including engine nacelle is replaceable and wing tips, horizontal and vertical tails and fuselage nose and tail sections are replaceable as units.

Shipment by railroad or truck is possible by removing the wings at the wing root inboard of the engines. This is done by removing six bolts and bracing the main landing gear.

The landing gear is tricycle with a 360-deg. swiveling nose wheel. Normal actuation is hydraulic with one-shot pneumatic blowdown available in an emergency. When skis are fitted, the nose wheel doors are removed. The nose ski is then held closed by a spring bungee to cover the nose wheel opening. The main gear skis are more complex in that a hydraulic actuator rotates the gear 94 deg. inboard after takeoff and prior to gear retraction. Ski tests with the aircraft will take place at Grumman this winter.

The flight test program has not developed any serious problems thus far, the only difficulty being a slight tail flutter which required smoothing the surface of the vertical fins. Some work also is being done on balancing the controls to trim out any heavy stick forces.

Skin Coating Studied To Cut Satellite Heat

Los Angeles—Heat-sensitive coating for satellite skins to control internal temperature automatically is being studied at Space Technology Laboratories' Physical Research Laboratory here. An experimental program is being considered to prove the basic theoretical analysis and devise various methods and techniques for applying coatings to change color, thereby controlling the heat absorption and radiation qualities of the satellite.

According to Rudolf Meyer, Space Technology Laboratories scientist, the coating can either take the form of a paint-like substance or a plastic applied in several layers. In the case of polymer compounds, use would be made of the reversible transition from the sol state to the gel state as temperature increases. Meyer has referenced about 35 substances which have this "chameleon" ability at the required temperature level.

Temperature inside the vehicle's shell would automatically be kept uniform, Meyer says. As temperature of satellite increases, its skin would become light in color, allowing more heat to be reflected into space. If the payload's internal temperature decreases, the skin would become dark in color, thereby absorbing more radiation.

Helicopters to Aid Satellite Recovery

Pt. Mugu, Calif.—Two new helicopter-carrying satellite recovery ships have been assigned to Pacific Missile Range headquarters here as part of the Discoverer recovery team based in Hawaii.

The ships, USNS Dalton Victory and USNS Haiti Victory, owned and operated by U.S. Military Sea Trans-

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PERFORMANCE

Speed (32,800 FT)	560 MPH
Time to 32,000 FT	6 MIN.
Service Ceiling	40,000 FT.

Production is now underway to supply the French Army, Navy and Air Force. It has also been recommended for use by the US 7th Army in Germany.

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STABLE PLATFORMS • INERTIAL GUIDANCE • RADAR ANTENNA STABILIZATION AND TRACKING SYSTEMS • GROUND SUPPORT EQUIPMENT

port Service, are now in Honolulu for final outfitting and personnel training. The two merchant-type vessels will replace a pair of fleet destroyers that were temporarily assigned the recovery mission. The ships will be operated by Civil Service MSTS crews.

Communications equipment and radars, beacon receivers and other devices to track the incoming satellite capsule will be operated by technicians supplied under contract by Bendix Radio Division. The ships are not equipped for regular orbital tracking. They will carry U.S. Weather Bureau meteorologists to make weather observations and forecasts. Navy personnel assigned to the ships will include the helicopter crews and frogmen.

When not on station, the ships will be based at Pearl Harbor and the helicopters will be based at Marine Corps Air Station, Haneohe. They will be on call to USAF's Hickam Recovery Center. The Discoverer project is administered for Advanced Research Projects Agency by USAF and Lockheed Aircraft Corp.

Northrop Builds Space Navigation System

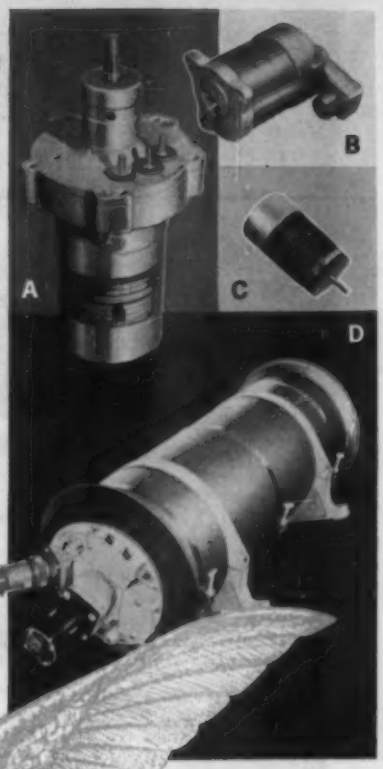
Los Angeles—Advanced celestial navigation system for missile and interplanetary space flight applications is in development here by Nortronics Division of Northrop Corp. under a contract from Wright Air Development Center Weapons Guidance Laboratory.

A Phase I feasibility study begun a year and a half ago has been completed and a Phase II contract for construction and field test of two prototypes is under way. Tests are about to begin. WADC contracts total $291,348 and an approximately equal amount has been invested by Nortronics.

Nortronics calls the new digitalized system a major advance in acquisition and processing of celestial navigation data. A star tracking problem is solved in under 10 sec. while Mk. I system in the Northrop Snark SM-62 requires as many minutes. An optical system scans electronically without any moving parts which seems to indicate use of a vidicon tube or some similar device. The system is called "much lighter and smaller than the Mk. I system." This is attributed largely to direct digital readout.

Companies to Enter Joint Simulation Equipment Bids

Tenney Engineering, Inc. (Union, N. J.) and Consolidated Electrodynamics Corp. (Rochester, N. Y.) have entered into an agreement to work together in bidding on and construction of high altitude simulation equipment.



A Emergency Feathering Torque Motor: 92 inch pounds torque, weighs 7.2 lbs., continuous duty, 400 cycle AC.

B Auxiliary Motor: 2.25 HP, weighs 3.9 lbs., intermittent duty, 28 volt DC.

C General Purpose: 0.14 HP, weighs 15 oz., continuous duty, 400 cycles AC.

D Helicopter Prime Mover: 240 HP, weighs 188 lbs., continuous duty, 400 cycle AC.

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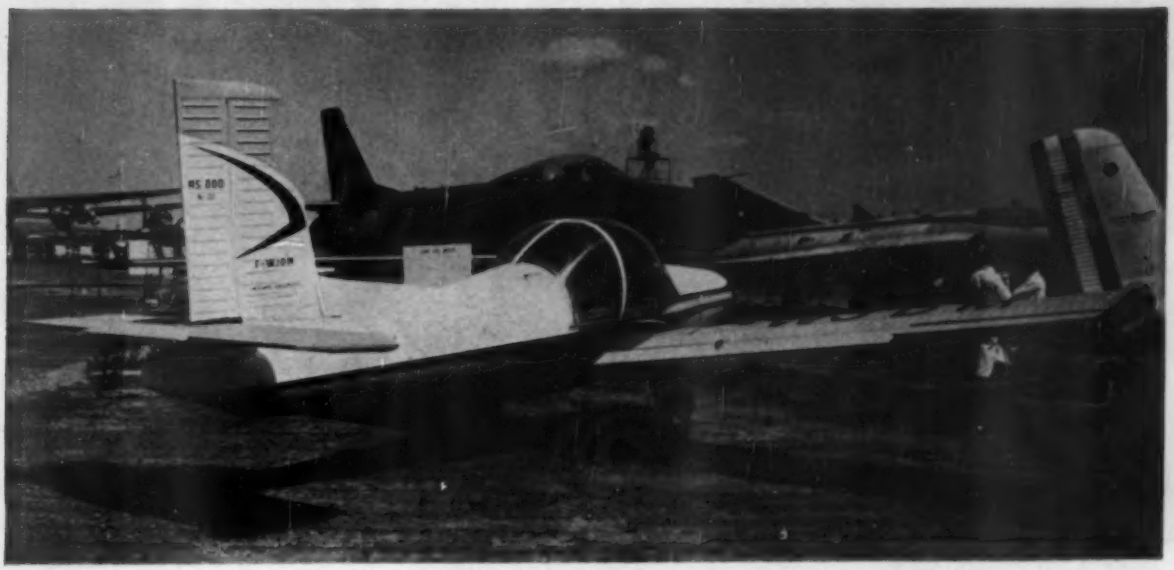
Austrian firm of Simmering-Graz-Pauker manufactures the M.222 Flamingo, twin-engine executive plane which made its first flight May 15. Powerplants are two O-320-A Lycoming engines rated at 150 hp. each. The plane is 28.5 ft. long, 10.7 ft. high and has a wingspan of 36.1 ft. Takeoff distance is given as 985 ft. and landing as 557 ft. Maximum speed of the Austrian twin is 186 mph.

Europeans Display Sport, Executive Lightplanes

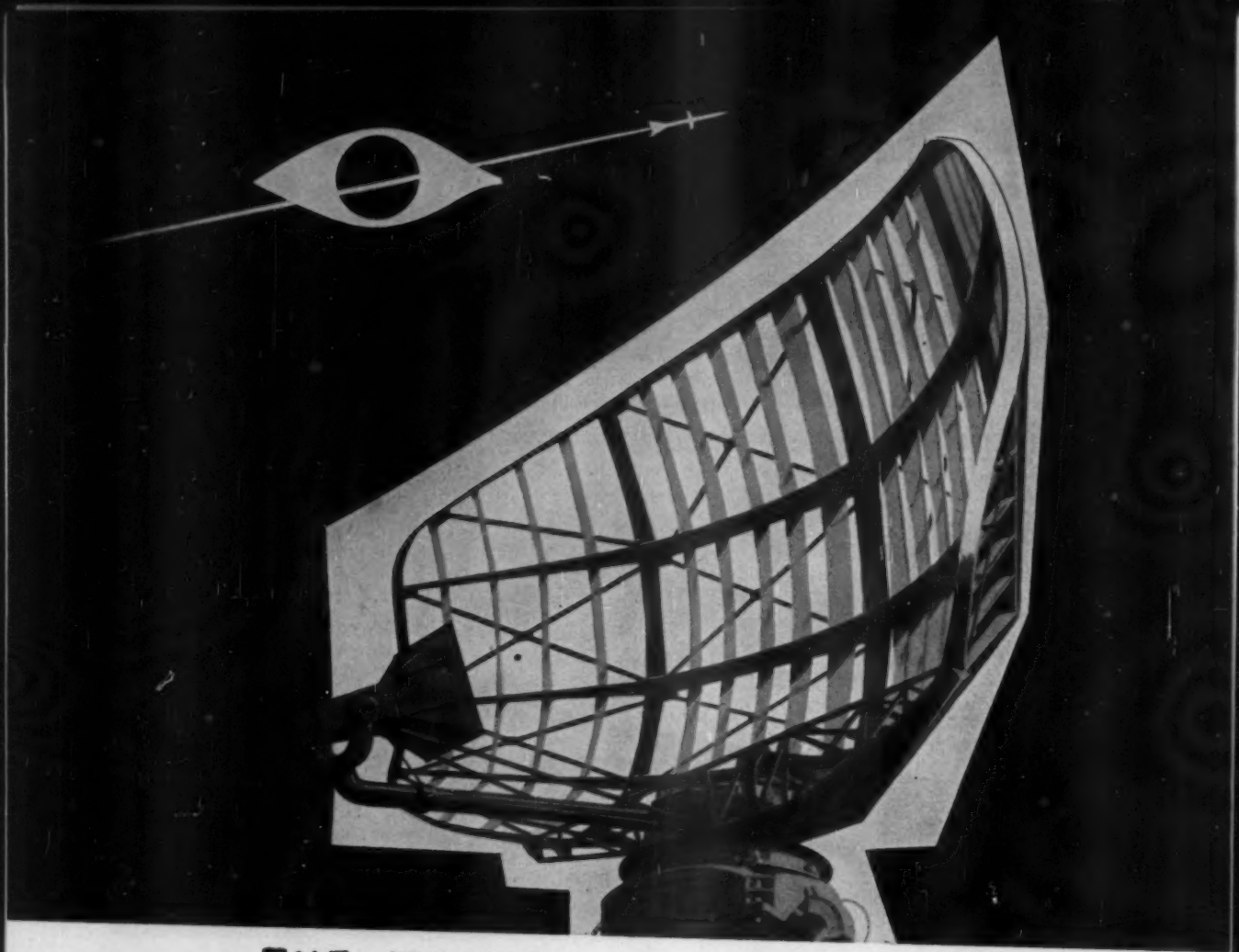
Super IV Wassmer, powered by a Lycoming 180-hp. engine, is displayed at the Paris air show. Made by Societe des Etablissements Banjamin Wassmer, plane first flew June 8. Gross weight is 2,645 lb. and wing area is 172 sq. ft. Span is 32.8 ft.

Sipavia twin-engined entry is former Boisavia Anjou four-place touring aircraft. Right propeller is in full-feather position for static display purposes. Note unusual faired tip fuel tanks. Normal cruise speed is 149 mph. Takeoff run is about 525 ft.



Morane-Saulnier Rallye is a two-seater sport plane powered by a 90-hp. Continental engine. Construction is all-metal, features tricycle landing gear and dual controls. The wingspan is 28 ft. Bubble canopy gives a high degree of visibility.

Helicop-Air Girhel autogyro has a three-bladed rotor 32.8 ft. in diameter. Two engines are available: a 90-hp. Lycoming and a 150-hp. Continental. Performance with the smaller engine shows a top speed of 102 mph., which increases to 133 mph. with the larger engine.



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Altitude Radar Cuts Controller Workload

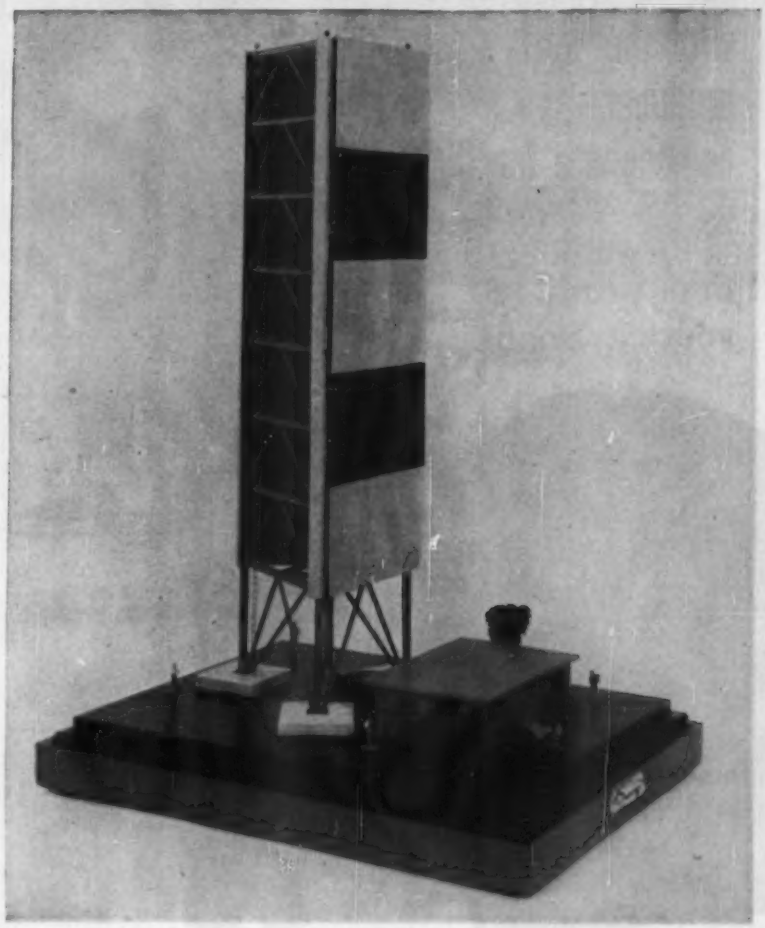
By James A. Fusca

New York—More precise control of aircraft in terminal areas by the addition of accurate and automatic altitude information to the displays of conventional airport surveillance radars will be studied by the Federal Aviation Agency.

The W. L. Maxson Corp. is developing a semi-active altitude finding radar system for installation at the agency's experimental center (NAFEC), Atlantic City, N. J., under a recently awarded $1.7 million contract.

Called the AHSR-1 Air Height Surveillance Radar, the system measures the elevation angle of reception for radar signals that have been reflected from aircraft targets in the terminal area illuminated by the associated airport surveillance radar (ASR). Target altitude is computed from range and elevation angle.

Principal advantages of the system are that it will provide aircraft controllers with the necessary information to separate aircraft vertically and provide a more positive method of identifying aircraft by altitude.



AIR HEIGHT Surveillance Radar (AHSR-1) operates in association with a standard Airport Surveillance Radar to provide altitude information for control of air traffic in the terminal area. AHSR-1 operates semi-actively, receives energy radiated by the associated ASR.

Workload Reduction

The system is expected to appreciably reduce the present ground-air communications workload by eliminating the need for reporting altitude and reducing the number of traffic advisories that must be passed to pilots. Part of the system will be in operation by next spring, and the complete prototype system in operation by October, 1960.

The AHSR-1 will have a maximum range of 50 mi. At that range it will have a resolution of 1,000 ft. and an accuracy of plus or minus 500 ft. To obtain this precision throughout 360 deg. of coverage with a fixed, non-rotating antenna, a multi-beam design is employed with beamwidths that vary from three mils at a one-half degree elevation angle to 1.4 mils at a 40 deg. elevation angle.

The AHSR-1 system was designed by Dr. Judd Blass, director of Maxson's Microwave and Missile Guidance Laboratory, for the Federal Aviation Agency's Bureau of Research and Development. Because the system employs more than 30 mi. of waveguide and more than 3,000 waveguide horns, all mounted on a tower, it has been irreverently termed a "plumber's delight."

The complexity of construction, however, is believed to be more than offset by the simplicity and maintainability of a system that employs no moving parts, substituting electronic signal processing for mechanical scanning.

In normal operation the AHSR-1 would be located about one-half mile from its associated ASR, and in communication with it by means of a microwave link. Elevation information received from aircraft targets illuminated by the ASR would be transmitted to a computer at the ASR site for altitude computation and combined display.

The AHSR-1 tower is a three-sided structure 160 ft. high. Waveguide matrices extend from the 25-ft. level to the tower top on all three sides. Each corner of the tower mounts two rows of waveguide horns extending from 25 ft. to the top of the tower, providing what is essentially three identical antenna systems each covering a 120-deg. sector to make up the full 360-deg. coverage pattern.

Ferrite Switching

As the antenna of the S-band airport surveillance radar turns in azimuth, the AHSR-1 system is switched by means of ferrite switching so that the output of the three sytsems is from the appropriate sector.

The waveguide network from which the elevation angle of reception is obtained is made up of both horizontal and vertical waveguide sections. On each side of the tower two identical waveguide systems are mounted, each

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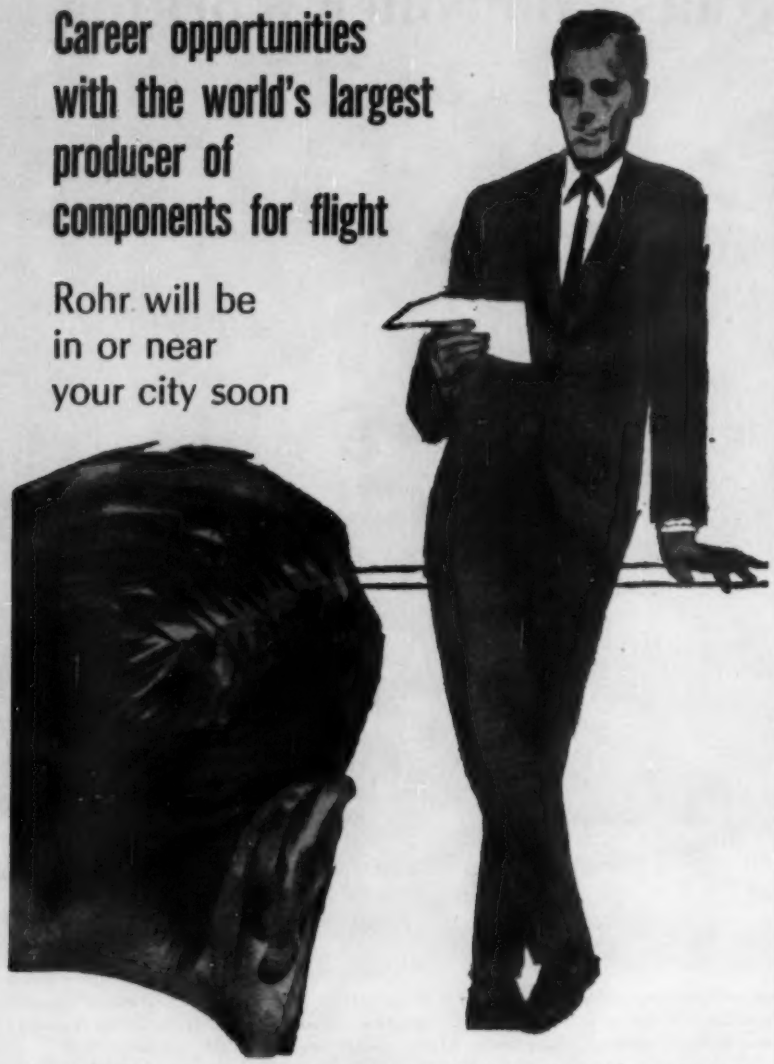

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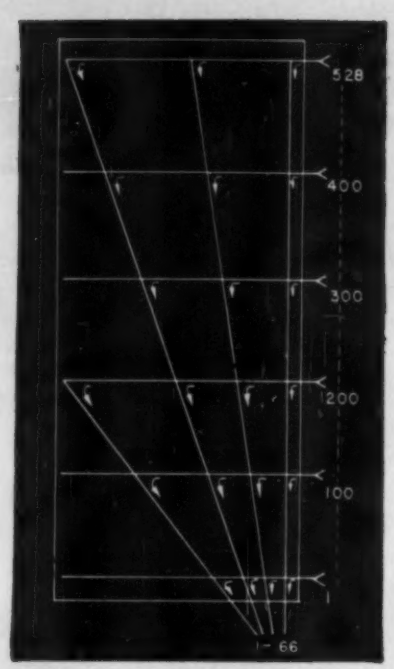


HORIZONTAL and vertical waveguide matrices for the AHSR-1 are shown schematically to indicate how the elevation angle of an aircraft target is found by determining which of 132 vertical waveguide runs, 66 for odd-numbered and 66 for even-numbered beams, receives energy from all the horns simultaneously.

pointing in the same direction. The purpose of having two complete systems is to provide more precise angular resolution through avoiding beam interaction by using one system for even numbered beams and the the other for odd numbered beams.

Each of the two systems employs 528 pieces of waveguide mounted horizontally, and terminating in a waveguide horn. All 1,056 horns are mounted horizontally without tilt.

The horizontal waveguide of each system is connected to the receiving system by means of 66 vertical or nearly vertical waveguide runs with directional couplers at each intersection of horizontal and vertical waveguide.

The first of these 66 waveguide runs is approximately vertical, and each following waveguide run is offset from the vertical at an increasing angle. The angle at which each run crosses the coupled horizontal waveguide determines electronically the elevation angle at which that run will receive energy reflected from a target. Because there are two complete systems for each sector, one for odd numbered and the other for even numbered beams, the total number of beams is 132.

The principle by which the waveguide matrix obtains 132 beam vertical coverage can be understood by imagin-

ing the 1,056 waveguide horns for one 120 deg. sector to be connected to a receiver by one piece of waveguide and the tower capable of being tipped. If the tower is tipped so that the signal wavefront reflected from an aircraft target arrives at each horn simultaneously, the signal input to all horns will be summed at the receiver. If the horns are not parallel with the incident wavefront, each horn will receive the signal at a different time and no appreciable energy will reach the receiver.

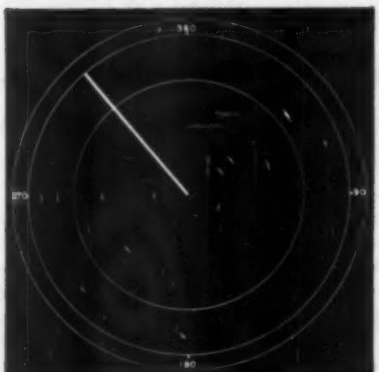
The effect of tilting the vertical waveguide runs so they cross the horizontal waveguide at different angles is similar in result to tipping the tower. The signal energy arriving at any elevation angle between ½ deg. and 40 deg. will be summed as the result of coupling to one of the 132 vertical waveguide runs simultaneously from the horizontal waveguide and waveguide horns.

Corrected by a factor of approximately 1.4 to allow for the difference in speed of propagation of radio waves in air and in waveguide, the angle at which the vertical waveguide crosses the horizontal waveguide is equivalent to the elevation angle of its beam.

Each vertical waveguide run is connected to a crystal mixer, pre-amplifier, and IF amplifier. Local oscillator frequency is controlled by a radar link receiver that receives the signals transmitted by the associated airport surveillance radar. The amplified signals are compared in a beam selector unit to determine which beams have received targets.

After parallax correction, received signals are transmitted to the ASR site where the height computer is located by frequency division multiplexed microwave data link.

At the ASR site the height computer determines the altitude of the received targets. This altitude information is



THREE dimensional display for control of aircraft in the terminal area uses outer one-fifth of a standard plan position indicator to present altitude information, inner area shows standard range and azimuth data.

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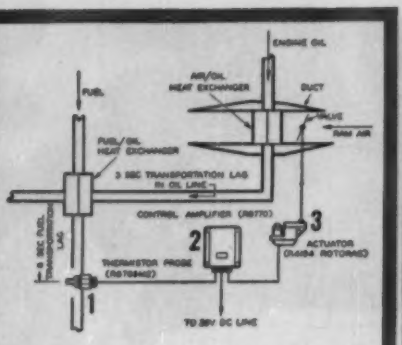
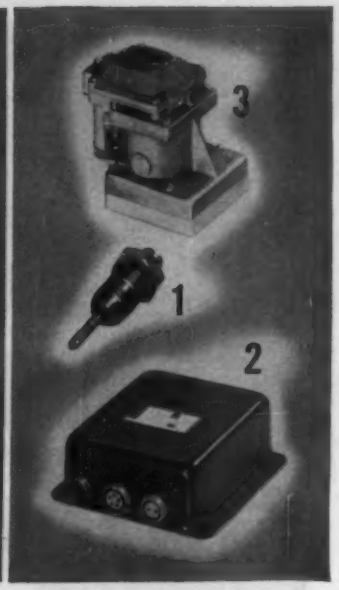


AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine-oil heat exchanger. Oil is used in turn to heat fuel.



Airborne electromechanical system regulates jet fuel temperature

An integral part of each main engine installation on the Martin P6M2 Seamaster is an Airborne R-8010 custom-engineered temperature control system. By regulating air flow through a heat exchanger, this system maintains supply line fuel at 180-220°F.

As developed for the P6M2, the R-8010 system consists of a thermistor probe, a control amplifier and a rotary actuator. The probe (mounted in an MS10057-12 fitting) is in direct contact with the temperature-regulated fuel and presents to the control box a resistance which is proportional to fuel temperature. In response, the control box energizes the actuator to change the setting of a ram air intake valve, thus regulating volume of air flow through an air/fuel heat exchanger. This sensing and response continues until prescribed fuel temperature is attained, at which point the system reaches a state of electrical balance.

A fail-safe feature is also provided. In the event of power failure, a magnetic clutch in the actuator is released, permitting the air valve to be pushed open by the force of the ram air.

This application* on the P6M2 illustrates only one of many possible adaptations of the Airborne R-8010 system for temperature control functions on aircraft, missiles and related equipment—cabin temperature control, engine temperature control, temperature regulation of fuel, oil, electronic cooling packages, etc. If you have requirements in these areas, we will be happy to make a proposal. Contact any of our offices.

*Described in detail in new Bulletin PS-4A, available on request.

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then sent to one or more of the following equipments: tracking computer, altitude layer processor, and three-dimensional display converter.

The type of three dimensional display presently under consideration employs the outer one-fifth of the standard plan position indicator for altitude display. In this way targets appearing on the standard display in range and azimuth will also appear in an altitude circle outside of the range display.

If an altitude layer processor is used, the air traffic controller can cause his display to show only those targets appearing in his assigned area. For example, if a controller were assigned the layer between 10,000 and 20,000 ft., his display would paint only those aircraft between these altitudes.

One disadvantage of this type of three dimensional display is the possible ambiguity when two aircraft are at the same azimuth. For the controller to know which aircraft is at which altitude he must either have followed the tracks of the two aircraft previously or depend upon the persistence of the tube phosphor to show previous positions.

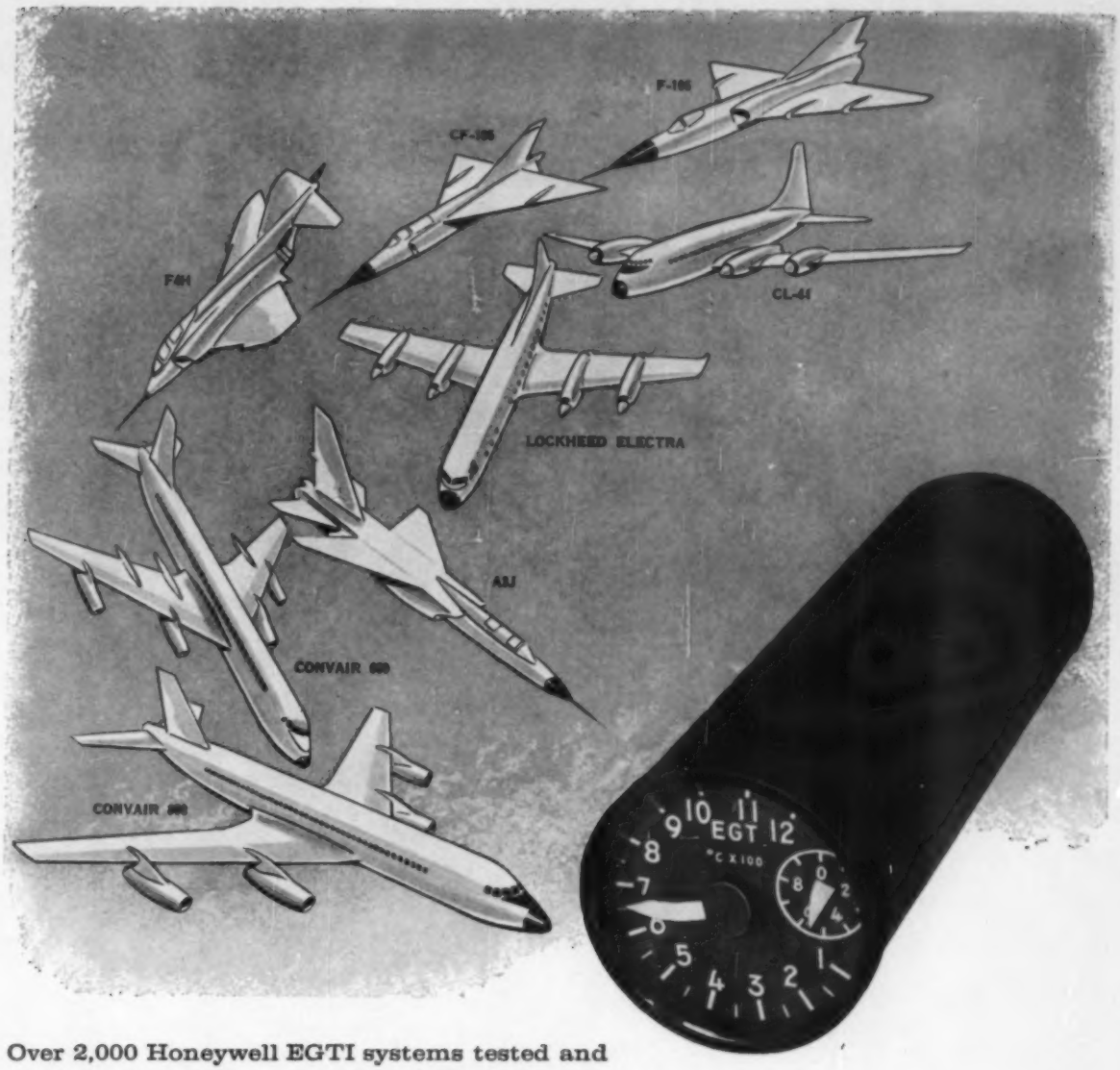
If the over-all system is as successful as is hoped, however, this type of problem is expected to be solved with relative ease.

Specifications for the system call for it to be able to present up to 20 aircraft targets at the same azimuth, and up to two targets at the same azimuth and range.

One of the problems encountered in conventional radars that will also be found with the AHSR-1 is that of "ghosts," or targets caused by other radars in the same area operating in the same frequency range. This problem can be solved, Maxson says, by using the de-ghosting equipment of the standard airport surveillance radar to generate "killer" pulses that would prevent the AHSR-1 from displaying ghost signals.

One feature of the AHSR-1 equipment that is expected to extend its usefulness is that a second receiving system similar to the S-band system but operating on L-band will also be installed. The L-band system will receive signals generated by the air traffic control transponders now being installed in commercial aircraft, and signals from the IFF equipment of military aircraft.

This system will use 160 dipole radiators connected to 27 feeds (corresponding to 27 beams) mounted on each face of the tower, and the received signals will be processed in much the same way as with the S-band system. Although the resolution of the L-band system will not be as fine, it will offer the advantage of being able to operate when the S-band system cannot.



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Polaris Navigation Aids Tested Ashore

Syosset, N. Y.—Integration and evaluation of the navigation systems to be installed in the Navy's Polaris-launching submarines is under way at Sperry Gyroscope Co. in a program that has included construction of an exact replica of a submarine navigational control center. Called the "Ashore Polaris Navigation Center," the test facility is identical to the planned submarine installations.

The center is part of a $1.7 million Sperry program for integration of the different but interrelated navigation systems that are scheduled to be installed and working aboard operational fleet ballistic missile submarines by the fall of 1960 (AW July 13, p. 34). By debugging the systems under the most realistic conditions possible, the Navy hopes to speed this complex and exacting part of the Polaris program.

Included among the systems to be tested are Navdac (Navigation Data Assimilation Center—a central navigation computer), Sins (Ship's Inertial Navigation System), and the Type 11 Stabilized Periscope System which enables the submarine to take celestial fixes while at periscope depth.

Polaris submarines cost approximately $100 million each, of which about $7 million represents the cost of the navigational equipment carried aboard. Sperry's development and integration effort for the Polaris program is expected to have a contract value of about $20 million for Fiscal 1960.

Navdac is a digital computer that monitors the three separate Sins systems that are the primary navigation aids and compares their outputs with the outputs of other equipments. Through this cross-checking system the navigational references required to guide the submarine and launch its missiles are obtained by comparing inertial references against periodic star fixes, measured speed logs, data on ocean currents, and similar inputs. The Navdac systems evaluates the accuracy of the different inputs to determine which data it wishes to accept. If the Navdac computer determines it to be necessary, it can realign one of the inertial systems.

The interrelationship of the systems can be seen from the example that to take a celestial fix the Navdac computer will take data from the Sins systems to direct the Type 11 periscope at a chosen star. The navigator then manually corrects the positioning of the periscope to compensate for accrued drift errors. Navdac feeds the correction data back to the Sins systems to realign them.

The Sins systems are the primary

TYPE 11 stabilized star tracking periscope (above) protrudes from a submarine sail that rises through the roof of Sperry Gyroscope Co. plant that houses the "Ashore Polaris Navigation Center" where integration and evaluation of the navigation systems to be installed in Polaris launching submarines is in progress. Navigation equipment within the center (below) includes three Sins, Ships Inertial Navigation Systems, suspended from overhead in case at left, and Type 11 star tracking periscope manipulated by technician in navigator's chair.

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EXPORT DIVISION, CURTISS-WRIGHT CORPORATION, 50 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK

NAVIGATION CENTER is an exact replica of a Polaris submarine navigation center, even to submarine hull section. Equipment is installed as it will be on board ship.

navigational references for the Polaris submarines. Systems for the first three submarines are being manufactured by the Autonetics Division of North American Aviation, and for the next two by Sperry. In addition to providing inertial data for navigation, the Sins systems feed data to the missile launching computers through a system called GTTS, standing for Gyro Transfer Table System, which is essentially a short term storage device that is isolated both from ship's motion and the earth's rotation.

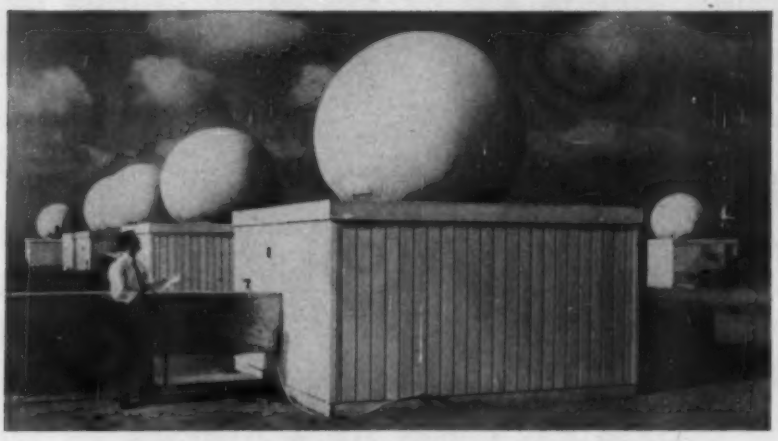
For the purposes of missile accuracy the most important data accepted from the Navdac computer is true heading. Because of this, the system has been designed to have an accuracy of about three seconds. The importance of accurate heading information can be seen from the fact that an error of one degree will give a miss distance of 17 mi. at 1,000 mi. range.

The Type 11 periscope incorporates a computer of its own, called Stardac, which compensates for submarine motion while a celestial fix is being taken.

To stabilize the submarines for missile launching, they are being equipped with stabilizing gyroscopes which have fly wheels weighing 23 tons. A Sperry system for Automatic Course and Depth Keeping and a separate system for automatic depth measuring are also scheduled to be installed.

Radio navigation aids include Loran A, Loran C (Cytac), and Draco. Draco is a moderately accurate VLF navigation system developed by Pickard and Burns which operates at long range. It has the advantage of being a "secure" navigation system in that it can utilize standard VLF transmissions to obtain navigation references, and can operate while the submarine is submerged.

IMPROVED AZUSA missile tracking instrumentation system is checked out (above) by Convair before shipment to Atlantic Missile Range. Four-foot parabolas of the system are protected by inflated radomes when in use, and by metal storm covers when not in use.



Azusa Mark II Missile Impact Predictor Equipment Improved

San Diego—Addition of two antennas, improvements in missile-borne transponder and refinements in ground based equipment are featured in Azusa Mark II missile impact predictor system now undergoing final checkout at Convair Astronautics plant here prior to shipment to Atlantic Missile Range.

Improved Azusa is expected to be installed and operating at Cape Canaveral early in 1960, according to Maj. Gen. Donald G. Yates, commander of Air Force Missile Test Center. Contract for $1,706,469 has been awarded Convair for installation of the impact predictor system.

Improvements over Azusa Mark I (AW Feb. 9, p. 65) which have been cranked into Azusa Mark II include coherent carrier incrementally derived range, a calibration reference waveguide, a 6-DB increase in transmitter power and real time digitized readout. In addition, the Mark II system uses 10 antennas instead of the eight used in Azusa Mark I. One antenna at extended distance has been added to both the X and Y axes of the basic Azusa antenna configuration to improve signal reception and give better data.

Further advances in Azusa, such as addition of correlation detection in transponder, would make space vehicle tracking possible, including computation of satellite orbits.

Performance specifications for Azusa Mark II call for a range of 1,000 naut. mi. (and to lunar distances with addition of narrow band and correlation circuits); range accuracy of 10 ft.; range resolution, ambiguous, 0.1 ft., nonambiguous, 1.0 ft.; range rate, standard, 30,000 fps., modified, 60,000 fps.; angle accuracy, 1/10 minus five; in cosine of either axis angle; angular resolution accuracy of comparable standard, and angular rates in azimuth of 1.0 radian per second, elevation 0.4 radian per second and cosine, 0.1 per second.

FILTER CENTER

▶**Solo for Army**—Army is considering use of Chicago Aerial Industries' new optical missile guidance system, called Solo, for upcoming tactical missiles. Contract to investigate Solo for "classified applications" will be announced soon. First details on lightweight, low-cost guidance system were revealed by AVIATION WEEK (Dec. 8, p. 67.)

▶**Transistor Circuit Manual**—Transistor Application Manual intended to aid engineers in the design of transistor circuitry for military applications has been prepared by Arinc Research Corp., under Defense Department contract. The 200-page manual includes recent failure and product variability data. Copies can be obtained for $1.50 each by writing to Arinc Research Corp., 1700 "K" St. N. W., Washington D. C.

▶**Signed on Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Epsco Inc.**, Cambridge, Mass., $16,500 contract from Naval Ordnance Laboratory for digital data printing system.

• **Hallamore Electronics Division** of The Siegler Corp., $250,000 from Hughes Aircraft Co. for a radio frequency signal generator to test advanced air-to-air missile. Company also reports a contract from Army Redstone Arsenal for installation of closed circuit television equipment to be used in missile engine static tests.

• **Computing Devices of Canada, Ltd.**, a Bendix Aviation affiliate, will supply dead reckoning navigation system for use on Lockheed F-104G aircraft purchased by West German air force. Amount of the initial contract is $1.6 million.

• **Whirlpool Corp.** research laboratories, St. Joseph, Mich., contract from Navy Bureau of Ships for development of thermoelectric temperature-controlled chambers intended to maintain electronic components at a constant temperature.

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Fabric covers for protecting wing and tail surfaces of light aircraft stored outdoors are made of vinyl coated nylon material. The fabric weighs 6 oz. per sq. yd. and is waterproof and shrinkproof.

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Yardney Electrical Corp., 40-50 Leonard St., New York, N. Y.

Convair F-106 Camera

Wing camera in the Convair F-106 jet interceptor takes 20 3-in. frames per second in photographing targets and flight paths of missiles.

The 35 mm. camera has a 6 in. focal length for high resolution. Two of the cameras, each 10 in. wide by 2½ ft. long are 7 in. high, are installed in the wings of a test aircraft. Cameras weigh 50 lb. each and are produced to Convair's specifications.

Benson-Lehner Corp., Los Angeles, Calif.

Fuel Oxidizer Nozzle

Missile fueling servicing nozzle utilizes safety interlocks to provide safety for ground personnel. The stainless steel and aluminum nozzle can handle any exotic fuels or oxidants except those requiring stoneware transmission equipment.

In closed circuit fueling operations, two nozzles are required to transfer propellant from the supply source to missile and overflow venting from missile to sources. Nozzle has a three way locking action between the nozzle and adapter. Operating temperatures are from −65 to +140F and the nozzle meets MIL-N-25556 and MIL-N-25555.

Lear, Inc., Lear-Romec Division, Elyria, Ohio.

Continental Develops Jet Age Passenger Ramp

Continental Airlines has developed a mobile ramp, with passenger steps covered for weather protection, for use in conjunction with Boeing 707 jet transport loading and unloading. Ramp automatically unwinds a gold carpet as it approaches the airplane.

Pitch Trim Compensator

Pitch trim compensator system, standard on Douglas DC-8 jet transports, compensates for change in trim characteristics in the transonic speed range, permitting the pilot to trim the aircraft in the normal manner.

Servocomputer computes Mach, compares it with the system authority curve and gives a command signal to a screwjack actuator on the pilot's control column. System has a pulse modulated output of 450 w. and delivers up to 500 lb. force at the base of the column. Mach sensing is provided by two absolute and differential pressure transducers. Unit weight is 11 lb.

Giannini Controls Corp., 918 E. Green St., Pasadena 1, Calif.

MILES M.100 STUDENT turbojet trainer has a span of 29 ft. 2 in., length of 31 ft. 6 in. and height of 6 ft. 3 in. Equipped tare weight is 2,400 lb. Maximum overload weight is 3,900 lb. Typical training duration is 1 hr. 40 min. Aircraft is not pressurized.

Aviation Week Pilot Report:

Miles Proposes Executive Student Jet

By Robert I. Stanfield

Paris—Lightweight, rugged and compact, the side-by-side, single-engine Miles Student jet trainer is a docile, easy to fly airplane capable of operating into small fields, a flight evaluation by AVIATION WEEK showed.

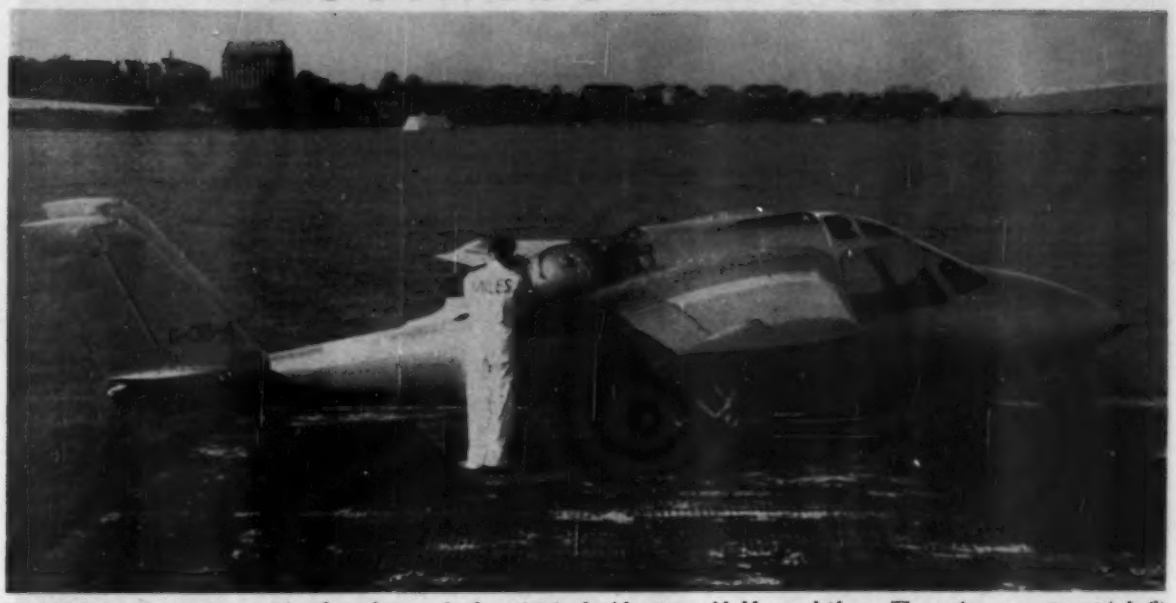
Designed primarily as an economical military and airline-pilot trainer by F. G. Miles, Ltd., of Shoreham Airport, Sussex, England, the little Student—empty weight is but 2,400 lb.; maximum overload, 3,900 lb.—is being considered for a secondary role as a four-place sport-executive airplane. Miles is initiating talks on this possibility with several U.S. manufacturers, one of which is the Piper Aircraft Co.

In event of an American marketing agreement, Miles would demonstrate the Student in the United States. Initial cost of a four-place commercial version, which could be fitted with two turbines in the 500-lb. thrust class, or the Continental J69-T25 of 1,025 lb. thrust, would approximate $50,000-51,000.

Miles is proposing that the airplane be built in England, with U.S. instrumentation and radios. Price would decrease with increased production, and orders for 20 aircraft would be necessary before go-ahead, AVIATION WEEK was told. Deliveries of commercial aircraft would begin within one year following orders.

Student prototype-demonstrator, which is waiting its first sale, was first flown in March, 1957. Power is supplied by a Blackburn Turbomeca Marbore 2A with thrust of 883 lb. and thrust loading of 4.1 lb./lb. Specific fuel consumption at maximum power is

STILL-AIR RANGE of the M.100 Student with tip tanks totaling 40 gal. is 621 stat. mi., with Blackburn Turbomeca Marbore 2A turbine engine. As a four-place executive-sport airplane, the Student probably would be powered by two Marbore 2As or a Continental J69-T25.



STUDENT sits close to the ground and can be completely maintained without use of ladder or platform. The engine compartment is built on to back of undercarriage bay. Wing center section is built in behind the rear cabin bulkhead. Plane is built around central keel.

1.15. Compression ratio at maximum rpm. is 3.85. Dry weight, less tailpipe, is 314 lb. Overhaul life is 350 hr., with an expectancy of 1,000 hr.

Features evidenced during a low-level flight evaluation (due to time limitation at the Paris air show) by AVIATION WEEK included:

• **Takeoff and climb.** Weighing 3,700 lb., into a 10 kt. wind, with outside air temperature 18C, the Student was airborne at 85 mph., after a run of about 1,000 ft. at 23,000 rpm. Initial rate of climb, with 20 deg. of flaps and gear down, was 500 fpm. at 110 mph. and 21,750 rpm. With the airplane cleaned up, the rate increased to 1,800 fpm. as climb speed built up to optimum of about 155 mph.

• **Level flight.** At 4,000 ft., outside air temperature 10C, engine speed reduced to 18,500 rpm., the Student indicated 175 mph. for a true reading of 187 mph. Economical cruise, at 17,500 rpm., promoted an indicated speed of 165 mph. for a true airspeed of 176 mph. Normal cruise at this altitude, engine turning 21,000 rpm., generates an indicated reading of 225 mph. for a true speed of 240 mph. Maximum speed at 20,000 ft., with Marbore 2A, is specified at 298 mph.

• **Pattern speeds.** Airplane has good slow-flight and safe-flight characteristics and for a jet its pattern speeds are on the low side. The pattern was entered at 140 mph., gear and "takeoff flaps" (20 deg.) being lowered on the downwind leg. Base leg was flown at 120 mph., full flaps were dropped, and final approach to a grass strip adjoining the takeoff runway made at 100 mph. The Student was "over the fence" at 85 mph. and stopped within 600 ft. following touchdown.

Pressurization Cost

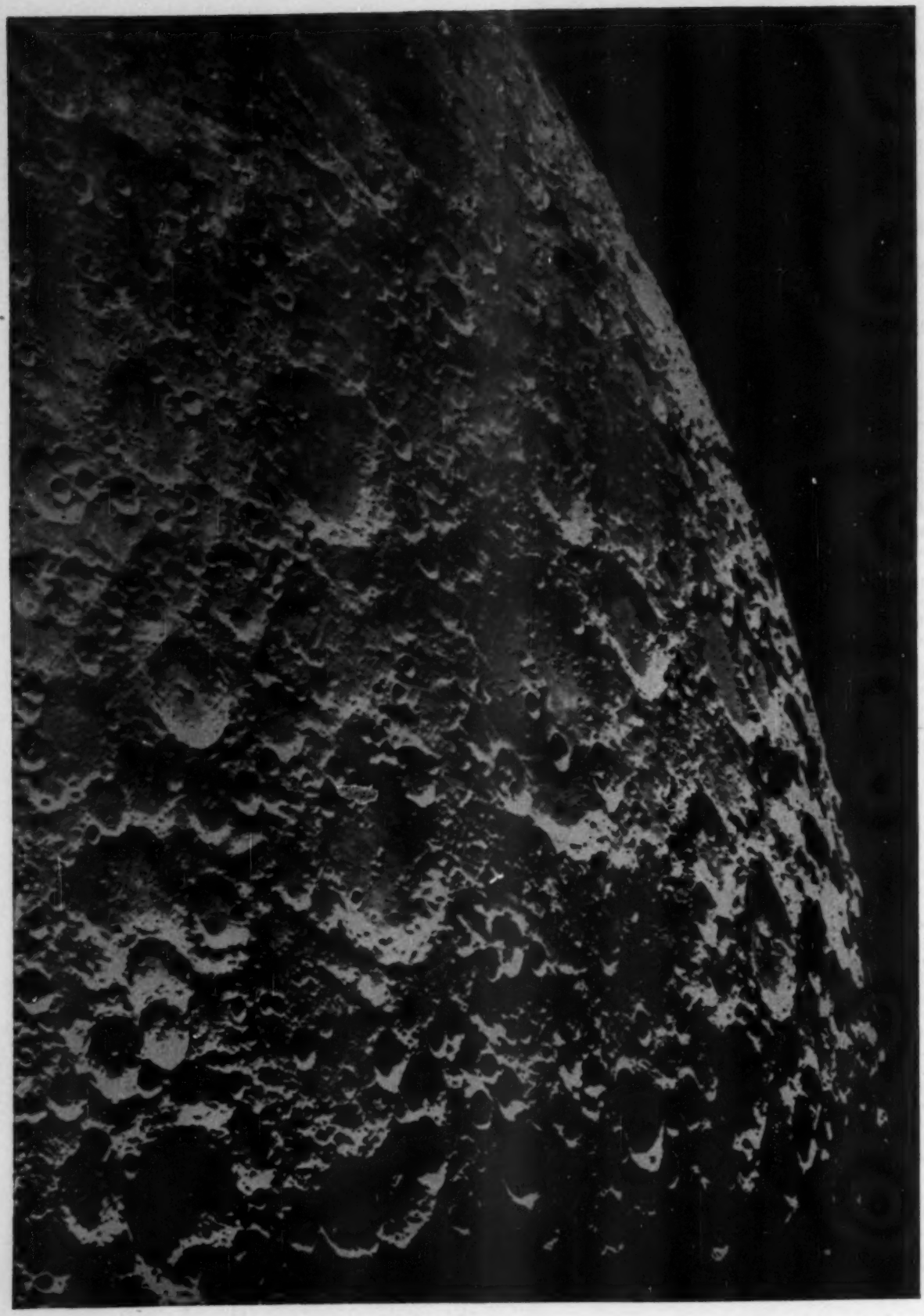
The Student is not pressurized or air conditioned, though the latter feature can be applied to production aircraft. Pressurization at additional cost would require design modification, which in turn would depend upon demand.

Wing span of the trainer is 29 ft. 2 in. Wing area is 144 sq. ft. Length is 31 ft. 6 in. and height 6 ft. 3 in. Fuel capacity is 100 gal., which increases by 40 gal. with addition of tip tanks. Still-air range, 100 gal. fuel (no reserve), with the Marbore 2A engine is 444 stat. mi.; with tip tanks, 621 stat. mi. By comparison, the Continental J69-T25 turbine increases the range to 455 and 637 stat. mi., respectively. The

Miles Student Performance

(at 3,500 lb. gross weight)

	Blackburn-Turbomeca Marbore 2A	Continental J69-T25
Takeoff over 50 ft., still air	2,220 ft.	1,920 ft.
Landing over 50 ft., still air	1,920 ft.	1,920 ft.
Initial rate of climb	1,780 fpm.	2,220 fpm.
Time to 10,000 ft.	6.8 min.	5.4 min.
Time to 20,000 ft.	17.4 min.	14.0 min.
Maximum speed, sea level	290 mph. (251 kt.)	313 mph. (272 kt.)
Maximum speed, 20,000 ft.	298 mph. (258 kt.)	310 mph. (269 kt.)
Cruise speed, sea level	253 mph. (220 kt.)	289 mph. (251 kt.)
Cruise speed, 10,000 ft.	260 mph. (225 kt.)	285 mph. (248 kt.)
Cruise speed, 20,000 ft.	262 mph. (228 kt.)	280 mph. (243 kt.)
Stalling speed	68 mph. (59 kt).	68 mph. (59 kt.)
Range flying speed, 20,000 ft.	228 mph. (198 kt.)	233 mph. (202 kt.)
Still-air range, 100 gal., no res.	444 stat. mi. (385 n.m.)	455 stat. mi. (395 n.m.)
Still-air range, 140 gal., no res.	621 stat. mi. (539 n.m.)	637 stat. mi. (553 n.m.)
Maximum duration at cruising threshold speed with 100 gal. (no reserve)	2 hr. 15 min.	2 hr. 20 min.
Typical training range	327 stat. mi. (284 n.m.)	325 stat. mi. (282 n.m.)
Typical training duration	1 hr. 40 min.	1 hr. 40 min.



THE
MILITARY
REQUIREMENTS
FOR
MOON BASE

This is the title of one of four major space proposals developed by Martin for the military and astroscientific branches of our Government. The importance of this proposal is two-fold: the inevitability of an actual moon base program by this country within the next 5 years, and; the fact that we could and can undertake such a project now— not in theory but in "hard" engineering design. For Martin's eight divisions add up to one of the top capabilities in the free world for man's first ventures in space-planetary exploration.

MARTIN
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Specifications

Wing span	29 ft. 2 in.
Length	31 ft. 6 in.
Height	6 ft. 3 in.
Wing area	144 sq. ft.
Wheelbase	10 ft. 5 in.
Main tires	600 x 6
Nosewheel tire	500 x 5
Fuel capacity (main tanks)	100 gal.
Fuel capacity (tip tanks)	40 gal.
Equipped tare weight	2,400 lb.
Gross weight	3,600 lb.
Maximum gross weight	3,900 lb.
Wing loading	25 lb./sq. ft.
Design Conditions:	
Ultimate flight factor	10@3,600 lb.
Design diving speed	460 mph. (400 kt.)
Design takeoff weight	3,600 lb.
Design landing weight	3,600 lb.
Crash load factor	25g

Engine: Blackburn Turbomeca Marbore 2A with thrust of 883 lb. and thrust loading of 4.1 lb./lb., or; Continental J69-T25 with a thrust of 1,025 lb. and thrust loading of 3.5 lb./lb.

J69 also will generate a speed increase of from 12 to 25 mph., depending on power setting and altitude, over the Marbore 2A. Additional range and power would enhance the sport-executive sales possibilities of this airplane, the best altitude for which is presently specified at 10,000-15,000 ft.

Low height of the high-wing airplane is a deterrent to overturning and makes for easy maintenance. Engine is placed above and behind the cabin and a bulkhead formed by the main wing spar, and position of air intake reduces hazard of foreign-particle entry and risk to ground crew.

All parts of the trainer can be reached without platforms or ladders. Primary mechanisms are situated in the main fuselage, leaving wings and tail of utmost simplicity. Airplane is built around a central keel, extending from nose-wheel attachment back to behind the main wheels. The keel would act as a protective member and as a skid in event of forced landing.

Cabin top comprises a complete unit above the keel, and landing gear bay is brought up from behind to fit onto the rear of the keel. Wing center section is built in behind the rear cabin bulkhead and the engine compartment is built onto the back of the landing gear bay. Alternative engines can be adapted for use with no structural modifications.

Structural parts which would affect pilot safety in event of an accident

PRODUCT SUPPORT ENGINEERS

Urgency–Speed–Reliability. These words describe Convair-Astronautics' top-priority program of activating Atlas ICBM bases throughout the United States. Included in this immense task is the job of training Air Force personnel, developing and producing hundreds of technical manuals and providing technical assistance to the Air Force. The Product Support department at Astronautics is responsible for this assignment and to fulfill it must double in size within the next two years. Engineers qualified to participate in this long-range program will find excellent growth opportunities in the following areas:

CUSTOMER TRAINING – Service Training Instructors–Engineers with degrees in ME, AE or EE, or equivalent hardware experience are needed to prepare and conduct continuing 4-6 month courses to Air Force personnel on the Atlas ICBM. This training will include classroom theory and hardware manipulative skills to a high level of proficiency.

Service Training Planners – Men with 2-5 years experience in the planning of industrial and/or armed services training programs are needed for the planning, preparation, editing and publishing of training material for the Air Force. This assignment will also include training standards, syllabuses, lesson plans and training projects.

TRAINER DESIGN – Trainer design engineers (electronic and mechanical) with degrees in ME, AE or EE are needed to design simulators to be used in the training of Air Force personnel on the Atlas weapon system.

FIELD SERVICE – Engineers, preferably with degrees in ME, AE or EE, and field or in-plant hardware experience are needed to act as technical representatives to the Air Force on the Atlas ICBM. Most assignments will be at Vandenberg AFB, Santa Maria, Calif. There will be other assignments as additional Atlas bases become operational. A limited number of San Diego openings also exist in the areas of Field Service Support. A field service bonus of $210.00 per month is authorized for field assignments in excess of six months. Per diem paid for assignments under six months.

TECHNICAL WRITING – Engineering degree preferred, plus 1-3 years of technical writing experience. Assignments include the writing of engineering reports, maintenance manuals and operation manuals.

Our engineering representatives will be conducting

INTERVIEWS

in these cities soon:

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Call our permanent recruiting offices – in Detroit, LI 9-3038; in New York, EL 5-3550.

Qualified Product Support Engineers are urged to send a detailed resume at once so advance arrangements can be made for a confidential interview. Write to Mr. T. W. Wills, Engineering Personnel Administrator, Department 5612.

CONVAIR/ASTRONAUTICS

CONVAIR DIVISION OF

GENERAL DYNAMICS

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are stressed to withstand 25g. Controls are by push-pull rods throughout.

Side-by-side cabin of the Student is quite roomy and comfortable. Cabin width is 48 in. Headroom runs 45 in. and maximum leg room is 47 in., minimum 39 in. Space behind tilting pilots' seats, normally used for stowage, can be converted to back seats.

Cabin is entered via large car-type doors, the sills of which are only 18 in. above the ground. Doors measure 46 in. x 41.5 in. In event of an emergency bail-out, the pilot would operate a handle within the cockpit which would pull out hinge pins and a check-strap from the front of the door, allowing it to fly outward and the pilot to roll out of the airplane.

Seating is comfortable in the small trainer, and visibility is good on all sides, particularly since the high wing sits behind the cockpit. Ailerons, rudder and elevator are activated by a stick-type control. Power controls are located on center quadrant between seats; additional throttle adjoins instructor's seat.

Flight instruments are centered on the main panel, in two rows. Engine instruments are located at bottom-left on the panel; ammeter and voltmeter are at bottom-right. Pedal adjustments are on far sides of panel, for each pilot. Warning lights for fuel pressure, gear, dive brakes, engine fire, etc., are on the lower portion of main panel, forward of the quadrant, which also contains flap and gear levers and controls for dive brake, fuel selection, and starting. Radio panel (VHF) is located on main panel in front of the copilot.

No Braking

The Marbore 2A fired up quickly, and the Student was easily taxied out with no braking necessary in turns. Nosewheel is steerable 22 deg. either way and the aircraft can be turned almost about its own wingtip. The pilot can select "nosewheel free" to pivot about main wheels or for towing and ground handling. Goodyear disk brakes are fitted on main wheels.

There are two flap positions: takeoff, 20 deg., and landing, 45 deg. With all instruments in the green, 20 deg. were lowered and the Student was ready to roll. Along with the AVIATION WEEK pilot in the prototype, G-APLK, was Miles test pilot Duncan McIntosh.

Field elevation at Le Bourget is 180 ft. Sea level pressure was 1,016 mb. Outside air temperature was 18C and wind was from the northeast at 10 kt.

Takeoff was made on Runway 3, at takeoff weight of 3,700 lb., CG 24%. With power applied, brakes were held for a few seconds, then the Student moved swiftly down the runway, the nosewheel coming up at 85 mph. at which time the trainer was pulled off. During initial takeoff, engine pulling

high-energy fuel briefs from Callery

Callery opens office in Los Angeles—Fuel and propellant users on the West Coast can now contact Dr. Robert G. Brault, Callery's Manager, Western District, for helpful technical service. He has opened an office at 3141 Century Boulevard, Inglewood, California. Telephone: ORegon 8-9382. Dr. Brault was formerly Research Coordinator of the Project Zip high-energy fuel program at Callery's R & D Laboratories.

Diborane as fuel for rockets, ramjets, and turbojets—With a heat of combustion of 31,300 Btu/lb. and extremely good combustion properties, Diborane is an attractive fuel for air-breathing engines. Diborane, a gas at standard conditions, can easily be liquefied (boiling point –134°F). With modern insulating methods, it should be storable for long periods. Its specific gravity at a temperature slightly above its melting point (–265°F) is 0.56, so that it contains more Btu/gallon than JP fuels. Diborane has excellent heat-sink capabilities.

Recent calculations, based on the most recent thermodynamic data, show Diborane-LOX to have an I_{sp} of 349 sec. (1000/14.7 psia, shifting equilibrium). With its higher density and boiling point, it may be superior to hydrogen for some applications. Diborane will soon be available in tonnage quantities. Write for Technical Bulletin C-020 for detailed information.

HiCal® fuel now available—Since Callery's production of HiCal, high-energy fuel, will exceed immediate military test-program requirements for the next few months, substantial quantities of HiCal-3 are now available for authorized users with suitable security clearance. If you have been waiting to test HiCal-3 in engines or components, write now for specific information. Our HiCal-3 Handling Bulletin C-1100 is available on request.

New specific-impulse calculations—Specific-impulse data for several combinations of boron-containing fuels with various oxidizers have recently been calculated and tabulated. Most of these data are confidential, but Callery representatives would be pleased to discuss them with you on a classified basis.

Fire-fighting films on HiCal and pyrophoric fuels—The HiCal film shows the relative ease and safety with which a stable mechanical-foam blanket can extinguish burning HiCal fuels. Another 15-minute film illustrates the techniques available for combating fires of Trialkyl Boranes.

For information or loan of films, write to Defense Products Dept., Callery Chemical Company, 9600 Perry Highway, Pittsburgh 37, Pa.

CALLERY
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9600 PERRY HIGHWAY PITTSBURGH 37 PENNSYLVANIA

Dr. Robert G. Brault
Manager
Western District
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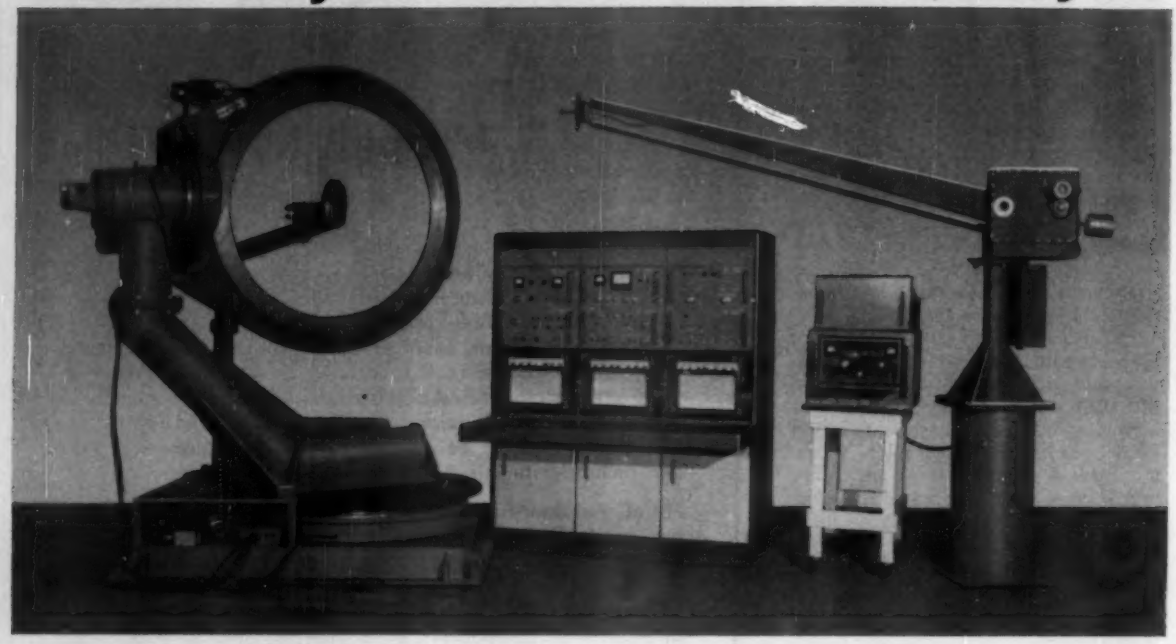

TEST RADOMES TO MIL-R-7705A (ASG)

• including type II radomes • automatic recording of boresight error with overall system accuracy of ±0.1 milliradian ($\pm\frac{1°}{175}$)

The effectiveness of the best airborne radar tracking system can be completely destroyed by deflection of the radar beam as it passes through the plastic radome. Now, for the first time, radome manufacturers and aircraft firms installing radomes can be completely assured of radome quality. CTI Automatic Radome Boresight-Error Measuring System replaces tedious spot checking with a continuous recording of beam shift across radome.

In the system shown above, as the motor-driven holding fixture rotates the radome under test, the servo-controlled null-seeking antenna on the boom traces the position of the deflected radar beam. At the control console, which provides single-point control of the entire system, three recorders plot the total magnitude and horizontal and vertical components of the beam deflection angle directly in milliradians. Rate of change of beam deflection, essential to missile applications, is readily obtainable from the recordings.

Additional features include automatic plotting of antenna patterns with or without the radome and radome transmission efficiency measurements. The system is available in frequencies from S through K_a bands and infrared.

For bombing-type and other radar systems using shaped-beam antennas, this beam-seeking unit replaces the null-seeking unit.

Engineers: Career opportunities are currently available at CTI

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23,000 rpm., jet pipe temperature was 610C.

Gear is retracted by double-acting rams fed from the pneumatic system. Gear doors are actuated by direct linkage from the legs. Rate of climb, dirty, was 500 fpm. until retraction, then increased to 1,800 fpm. Speed built up from an initial climb of 110 mph. to 155 mph., and power was reduced to 21,750 rpm.

Noise level during the climb was low, as was visibility. Airplane "felt" good, and was not overly sensitive. Jet pipe temperature dropped off to 500C, and at 4,000 ft. rate of climb was 1,000 fpm.

Cruise speeds, as mentioned earlier, ran from 165 mph. to 225 mph., indicated, at this altitude, for true readings of from 176 mph. to 240 mph. The airplane was quite responsive to all control pressures and was highly maneuverable and stable.

Stall Characteristics

The Student was stalled clean and "dirty" (in landing configuration). With power to flight idle, gear and flaps up, nose was pulled up straight until a slight buffet was felt in the stick. At about 82 mph., stick full back, the left wing fell and a break occurred. Wings leveled off as the stick was brought forward, and with speed build-up the nose came up with little loss of altitude.

Same procedure was followed with gear and full flaps lowered. In this instance buffeting again proceeded the stall by about 10 mph. The break came about 75 mph., with right wing dropping. No power was added as the airplane fell off, but with stick brought forward the airplane again leveled off and nose came up as speed increased. Airplane was quite docile throughout, and at low speeds can easily be maneuvered.

Student was then trimmed up and did a good job flying by itself. Hands-off, it held position and altitude in turn, and evidenced its applicability for easy transition from piston-driven aircraft to jet.

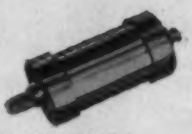
Approach to traffic pattern was made at 165 mph., speed brake activated for slow-down. After slight pitch-up, gear and 20 deg. of flaps were lowered and speed reduced to 140 mph. Brake was retracted. Base was flown at 120 mph. where full flaps were lowered. Final was flown between 95 and 100 mph.

Airplane was flared out at 80 to 85 mph., and touchdown made on grass strip adjoining runway. The trainer has good small-field capabilities and was brought to full stop after a roll of not more than 600 ft. Once accustomed to the aircraft, the landing roll could be further reduced.

Both British European Airways and British Overseas Airways Corp. have expressed interest in the Miles Student

Mc/S/A Controlled Explosive Ordnance

for Missiles, Rockets, and Space Vehicles



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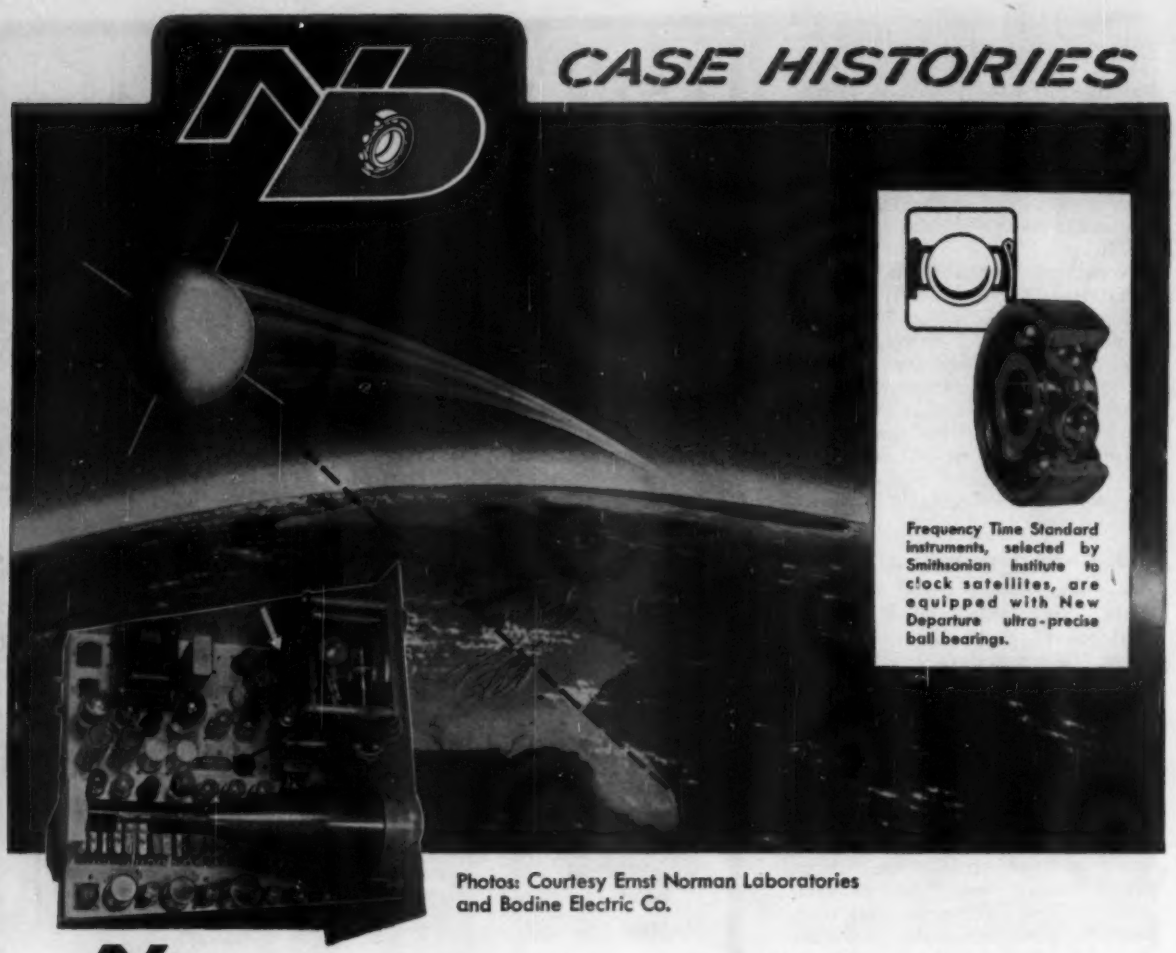


Frequency Time Standard instruments, selected by Smithsonian Institute to clock satellites, are equipped with New Departure ultra-precise ball bearings.

Photos: Courtesy Ernst Norman Laboratories and Bodine Electric Co.

Ultra Precise Ball Bearings Help "Clock" A Satellite!

CUSTOMER PROBLEM:

Require ultra-precise bearing design for Bodine electric motor used in satellite-tracking micro-clock. Bearings must provide uniformly low starting torque, precise location of rotor shaft and minimum maintenance, to help mechanism achieve time determinations to 0.001 second.

SOLUTION:

N/D Sales Engineers studied special bearing requirements, and recommended New Departure ultra-precise ball bearings. These ball bearings measured up to every requirement for micro-clock motors . . . thanks to New Departure's advanced equipment for research, development and production. N/D equipped micro-clocks, selected by the Smithsonian Institute, are operating in a dozen locations around the world right now, keeping track of vital satellite movements . . . to accuracies of one millisecond and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department G-7.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

as an airline-pilot trainer, in which pilots would be trained in turbine operations from the start.

Fuel in the trainer is isolated from the cabin. Fuel feeds by gravity from four main flexible tanks in the wings to the collector box, in which is a booster pump. From the pump fuel is fed via the inverted flying recuperator directly to the engine.

In the event of pump failure, engine runs by gravity feed.

When tip tanks are fitted, fuel is fed from them to the main tanks by line pumps, with warning light indicating to pilot when tip tanks are empty.

Student's pneumatic system operates at 40 psi. from an engine compressor bleed, and activates gear, flaps and dive brakes. Two reservoirs under the engine provide reserve air to operate entire system through three complete cycles. An emergency high-pressure bottle is fitted below the cabin instrument panel.

Electrical system is 28v. supplied from a 1,000 watt engine-driven generator and a 25 amp.-hr. battery. Engine can be started on internal power. Inverter is provided to supply 115v. gyro instruments when fitted.

Currently in design status, and somewhat similar in appearance to the Student, is the Miles Centurion, a five-place personal transport and service communications aircraft. The Centurion could utilize twin Continental J69s or Marbore 2As, as well as a single Rolls-Royce R.B. 145 or Bristol-Siddeley Viper engine.

Miles will not build the Centurion as a private venture, AVIATION WEEK was told, unless orders totaling at least 20 aircraft are procured. A prototype could be built within one year, with production under way in two. The airplane would be lightly pressurized to 20,000 ft., air conditioned, and cost about twice the price of the Student.

Centurion would embrace a span of 32 ft. 6 in., length of 31 ft. 9 in., and height of 7 ft. 4 in. Wing area would be 182 sq. ft. Tare weight would be 4,282 lb. and gross weight 7,300 lb. Fuel would be carried in wing pods instead of external tanks, and capacity would be 275 gal.

Centurion performance estimates are as follows (with Rolls-Royce R.B. 145 engine at 7,300 lb.): Takeoff and landing distances (over 50 ft.), 2,400 ft. and 2,790 ft. respectively. Initial rate of climb, 4,300 fpm. Time to 10,000 ft., 2.8 min. Time to 20,000 ft., 6.9 min.

Maximum speed at sea level would be 455 mph. Cruising speed at 10,000 ft., 440 mph.; at 20,000 ft., 445 mph. Stall speed is estimated at 88 mph. and still air range with 275 gal. (no reserve) is specified as 910 stat. mi. (790 naut. mi.).

Volitan Converting Douglas B-26s To 9-16 Passenger Transports

Los Angeles—Cabin accommodating 9 to 16 passengers is the main feature of a fuselage modification to surplus Douglas B-26 business transports engineered by Rhodes Berry consulting engineers and manufactured by Volitan Aviation, Inc., of Pacoima, Calif.

Its designers say increased passenger capacity and comfort will improve business utility of the B-26 without any important sacrifice in performance. B-26 owners can buy the modification for just under $100,000. The price was established to prorate costs over 10 aircraft.

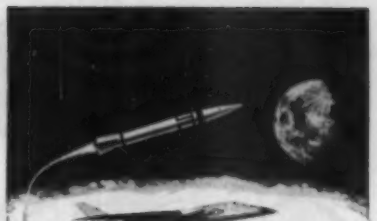
The first airplane is nearing completion and is expected to be delivered to Whiteman Manufacturing Co. later this summer. Volitan is tooling up to produce conversions at the rate of two per month. A higher production rate is possible if demand warrants it.

Volitan will also market the conversion in kit form. Rhodes Berry will design custom interiors ranging from nine-passenger de luxe arrangements to 16-passenger high density versions. If the conversion proves to be a financial success, a pressurized version may be built.

The fuselage modification increases cabin depth by 2½ ft. and cabin width by 7 in. to a total width of 55 in. through the constant section. Usable cabin length is 22 ft. The new lower fuselage is faired into the old loftlines from nose to tail.

Fuselage wetted area is substantially increased but Volitan says there will be no important sacrifice in performance because the new rounded fuselage eliminates undesirable flow separation which occurred over certain areas of the original fuselage.

The Volitan conversion has increased fuel capacity and with a gross takeoff weight of 35,000 lb. will fly Los Angeles-Chicago nonstop at speeds to 330 mph. with 65% power from standard Pratt & Whitney R2800-75/79 engines. Weight empty is under 22,000 lb. Added depth of the fuselage allowed Rhodes Berry to retract the nosewheel without first rotating it perpendicular to the line of flight as in the original B-26. Use of very small nosewheel doors provides an important drag re-

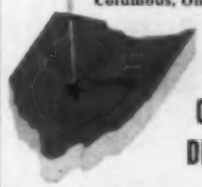


Dynamics Engineers

Here is your opportunity to join the Dynamics Section of the Columbus Division. Established only a few years ago, this Section is widely acknowledged as a leader in the development of Dynamic Science.

Major areas of activity are: 1. Aeroelasticity: structural stiffness analysis, flutter-vibration, environmental vibration, static aeroelasticity and acoustics. 2. Flight Loads: gust, landing, buffet, maneuvering and blast loads, and other studies of structural response to time dependent forcing functions. 3. Flight Dynamics: analysis of dynamics systems including structures, trajectories, aero-mechanical systems, crew escape systems, etc., utilizing precision analog computing equipment. 4. Dynamic Development: advanced design support, research contracts, specialized research in general field of dynamics. 5. Dynamic Testing: ground vibration testing, acoustic testing, aeroelastic model design and testing, flight vibrations and flutter testing.

For details, write to:
H. Keever
Engineering Personnel Manager, Box AW-408
North American Aviation, Inc.
Columbus, Ohio.



THE COLUMBUS DIVISION OF

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Home of the T2J Buckeye and the A3J Vigilante

COMFORT
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The Apache is a big, roomy airplane – roomier by far than any other twin anywhere near its class. There's plenty of cabin width and cabin height to give each passenger ample stretch-out, spread-out room. Whether your Apache is fitted with four standard individually adjustable and reclining seats or with optional five-passenger arrangement, each person has his own separate seat with abundant head, shoulder and leg room. Passenger comfort is only part of the story. New super-soundproofing means really quiet flight. Tasteful decor and fine styling of the interior appointments add a touch of luxury. Quality is evident throughout from the genuine leather seat upholstery to the fine, washable nylon fabrics. You'll be proud to welcome aboard the most discriminating passengers...and they'll be glad you did.

FLY THE 1959 APACHE with two 160 hp Lycomings, over 170 mph cruise, excellent single-engine performance, sensational short field get-up-and-go. See the completely new instrument panel with center-mounted radios. See how the amazing, low-cost Piper AutoControl gives you hands-free automatic flight in the AutoFlite Apache. See for yourself why more Apaches are bought than any other twin. Contact your nearest Piper dealer or write for Apache catalogue, Dept. W-8, Piper Aircraft Corporation, Lock Haven, Pennsylvania.

PIPER *Apache*

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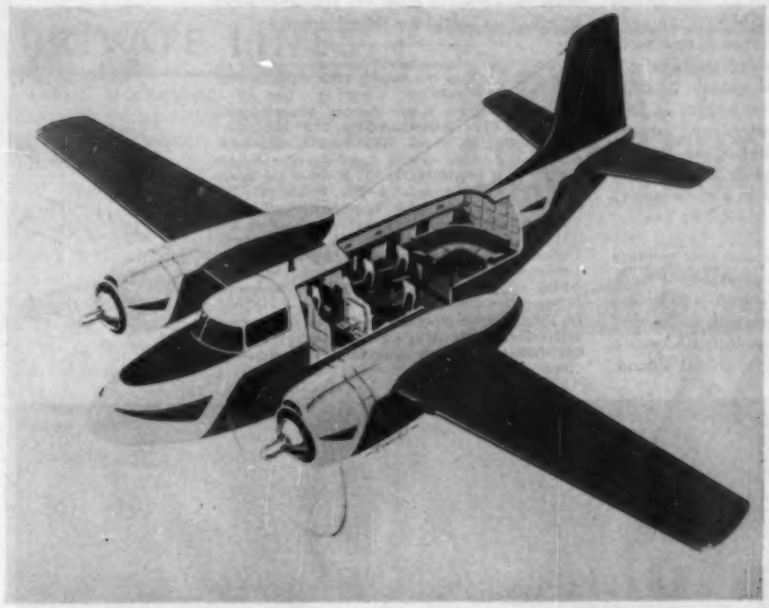
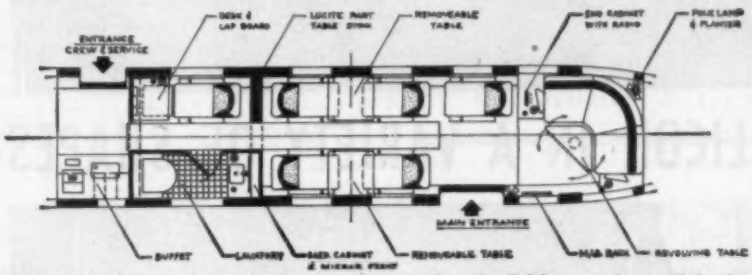


NINE-PASSENGER cabin configuration in Volitan Douglas B-26 conversion can be modified to seat 16 passengers. Usable cabin length is 22 ft., empty weight under 22,000 lb.



FUSELAGE width is increased by 7 in. in Volitan's Douglas B-26 conversion, and fuselage depth increased by 2½ ft. A 14½-in. aisle runs from the aft lounge to the cockpit.

duction during the first segment climb. Increased keel area of the conversion improves directional stability.

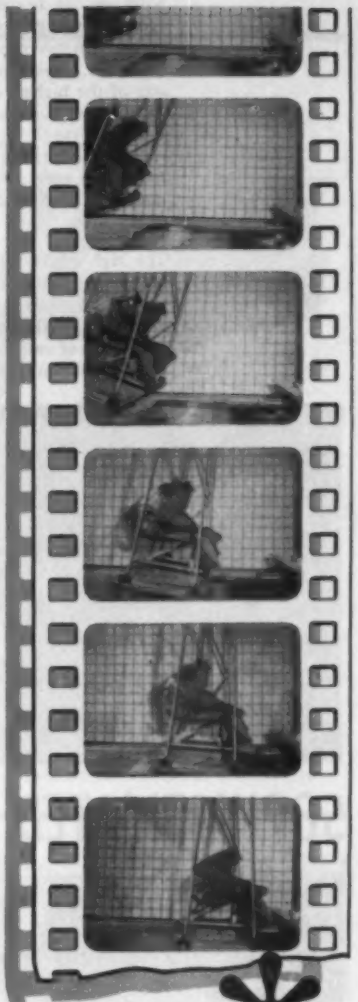
Folding steps are mounted on the downward-opening main passenger door in the left-hand side of the fuselage just aft of the wing and engine nacelle. There is a crew and baggage door on the right-hand side of the fuselage just aft of the cockpit. A 14½-in. aisle runs through the cabin from the aft lounge to the cockpit. The deeper fuselage allows easy passage under the wing carry-through, thereby eliminating one of the chief faults of the basic B-26. Passenger windows measure 16 in. x 18 in. except for two large panoramic windows on each side of the cabin.

Absorb Deviations

To avoid the usual difficulty of matching a new structure to old, new longitudinal members were designed for installation in the remaining part of the original structure to absorb any manufacturing deviations. The new structure was then designed to match the longitudinal members, thus eliminating the possibility of mismating the new lower section with the existing upper section.

The new lower fuselage was designed in four subassembly sections which can be manufactured on the floor and then assembled as complete units to the remaining part of the basic airplane. This avoids the time-consuming practice of rebuilding a piece at a time from the inside out. The remaining part of the original fuselage is changed from a monocoque-and-beam structure to monocoque throughout with new frames and special wing-fuselage joints. Two strong keel members are intended to carry landing loads in the event of a wheels-up landing because the new fuselage extends below the nacelle bellies.

New fuselage was designed around the strength criteria of the original airplane and CAR .04b for new structure, taking into account the high load factors of the original specification.



Here's how TECO pulls the "Stop" on high G's!

Gruelling tests, high-speed film sequences, concentrated engineering follow-through and confident investment in TECO-ability have paid off by making available the finest Energy Absorption unit for airline seats.

✳ For complete "How" facts on TECO Energy Absorption, or to see a run-through of the entire technical film—write: TECO, Inc., 3210 Winona Ave., Burbank, Calif.

TECO Aircraft Seats

Burbank, California

Now you can design silicon infrared optical systems with greater flexibility than ever before. Hughes has developed a new technique for *casting* pure polycrystalline silicon of the highest optical quality. Starting with cast silicon blanks—in shapes of flats ...domes (to 9" in diameter—and larger) ...lenses...prisms...Hughes can greatly reduce the necessary grinding. Result: economical silicon applicable to a wide variety of problems.

The high quality of these cast silicon parts has been established through extensive laboratory research. Spectrophotometric and scattering tests have proven that the optical properties of cast polycrystalline silicon are identical to those of single crystal silicon.

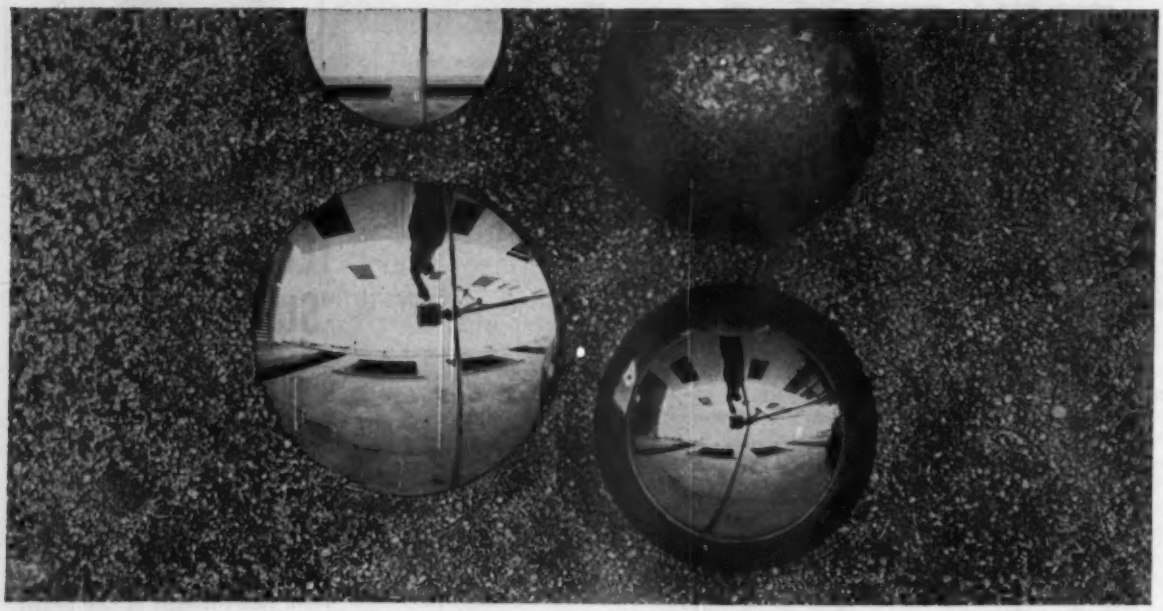
Wide variations in grain size proved to have no effect on scattering characteristics.

For additional information or more detailed test results please contact the Hughes sales office nearest you. They are located at:

BOSTON, 4 Federal Street; Woburn, Massachusetts; WOburn 2-4824. **MINNEAPOLIS,** 6121 Excelsior; Minneapolis 16, Minn.; WEst 9-0461. **NEWARK,** 80 Mulberry Street; Newark 2, New Jersey; MArket 3-3520. **SAN FRANCISCO,** 535 Middlefield Road; Palo Alto, California; DA 6-7780. **SYRACUSE,** 224 Harrison Street; Syracuse 2, New York; GRanite 1-0163. **CHICAGO,** 1515 N. Harlem Ave.; Oak Park, Ill.; NAtional 2-0283. **CINCINNATI,** 816 Swifton Center; Cincinnati, Ohio; ELmhurst 1-5665. **PHILADELPHIA,** 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365. **LOS ANGELES,** 690 N. Sepulveda Boulevard; El Segundo, California; ORegon 8-6125.

Or write: Hughes Products, Marketing Department, **SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.** *For export write: Hughes International, Culver City, Calif.*

SOPHISTICATED SILICON IN A VARIETY OF SHAPES



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PRIVATE LINES

Design modifications to reduce fuel consumption are being worked out for the rotor-tip ramjet engines on the Dutch Kolibrie helicopter. A spokesman for the Nederlands Helicopter Industrie said the work is scheduled to take about one year, but that the helicopter is considered as fully developed and serviceable right now. Complaints about economy of the engine operation have come from prospective customers for an agricultural version of the Kolibrie. Primary potential of the rotary-wing craft, according to the company, lies in the field of helicopter training.

Soviet spokesmen claim that a Kamov Ka-18 coaxial helicopter carrying two persons has broken the world's 500 km. closed-course speed record previously held by France. Ka-18 flew 340 mi. in 3 hr. 13 min. for average speed of 105.8 mph. French record of 66.607 mph. was set in July, 1953, with a Sud SE-3120.

Final group of 20 Beech Mentor trainers for Chilean air force have been flown away from the manufacturer's Wichita, Kans., factory. The delivery brought to 65 the number of Mentors purchased by the Chilean Air force.

Lycoming Division, Avco Corp., signed a distributors' agreement with C. Itoh & Co., Tokyo, covering all reciprocating engines.

Symposium for business and private pilots is being planned by Airwork Corp. at Millville, N. J., for Sept. 23-24.

A Cessna has been presented to Wycliffe Bible Translators, Inc., for missionary-linguistic work in Alaska. Presentation was made by Calvary Mennonite Church, Souderton, Pa.

Contract covering overhaul of Douglas R4D (DC-3) transports has been awarded Pacific Airmotive Corp. by U. S. Navy. Work is being handled at the company's Chino, Calif., facility.

Purchase of San Carlos Airport, Calif., by Harper Aviation will pave the way for a multi-million expansion program to serve business aircraft operators. Field will be enlarged and a 300-room motel and a restaurant added.

Two Cessna 150 two-seater lightplanes have been purchased by Electronics, Inc., Vermillion, S. D., for use as "inter-city commuter" transportation for the company's sales staff, supplementing its light twin airplane. Company manufactures motor steam cleaners.

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COCKEYSVILLE, MARYLAND

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Complete Engineering, Laboratory, and Manufacturing Facilities for Design, Development, and Production of Cartridge Actuated Devices.

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FLY THE GATEWAY ROUTE TO THE "HEART" OF HISTORIC AFRICA

Fly the route of history via Ethiopian Airlines! See Cairo . . . the Red Sea . . . and Ethiopia, Land of the Queen of Sheba. Africa offers today's *greatest business potential, newest travel adventure.* Fly overnight in luxurious DC-6B's from Frankfurt (now 4 flights weekly) to Greece, Egypt, Sudan, Ethiopia and Kenya. Incomparable service.

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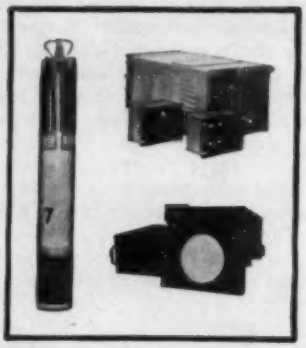
ETHIOPIAN AIRLINES

THE WONDERLAND ROUTE

AN ASW SYSTEM... DISPLAY/AIRBORNE RECEIVER/SONOBUOYS

Anti-submarine warfare equipment designed, developed and produced by *The Magnavox Company*, in conjunction with the Navy Department, provides patrol aircraft with eyes that see underwater by day and by night. The AN/ASA-16 Display System, together with SONOBUOYS, AN/ARR-26 Receiver systems and other associated equipment provide aircraft with a clear picture of the ocean-depths below them. They are part of the continuing contributions of *The Magnavox Company* in aiding the U.S. Navy to combat the growing submarine menace.

MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.



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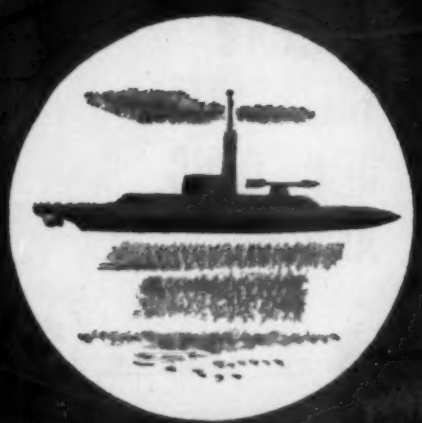
Magnavox

GIVES EYES TO NAVY ANTI-SUBMARINE WARFARE UNITS!



COMMUNICATIONS | RADAR | DATA HANDLING | ASW | MISSILES

THE MAGNAVOX CO. • DEPT. 97 • *Government and Industrial Division* • FORT WAYNE, IND.

WHO'S WHERE

(Continued from page 23)

Changes

Robert J. Brown, manager of marketing, General Electric Co.'s Heavy Military Electronics Department, Syracuse, N. Y.

Frederick R. Schroeder, Jr., administrative assistant to T. G. Lanphier, Jr., vice president and assistant to the president of Convair Division of General Dynamics Corp., San Diego, Calif.

Edgar J. Doolittle, director of business planning, Boeing Airplane Co., Seattle.

David A. Young, director of corporate long range planning, Aerojet-General Corp., Azusa, Calif. Also: **Robert L. Hirsch,** manager of the corporation's Washington, D. C., office.

Howard B. Lewis, chief engineer, Transducer Division, Consolidated Electrodynamics Corp., Monrovia, Calif.

Howard A. Zeimer, manager, Military Liaison Department, CBS Laboratories, Stamford, Conn. Also: **Dr. Nicholas Fuschillo,** head of the Laboratories' Solid State Physics Department.

Charles C. Goodrich, Douglas Aircraft Co.'s representative at the Army's Redstone Arsenal, Huntsville, Ala.

The Fafnir Bearing Co., New Britain, Conn., has announced the following appointments in the Product Engineering and Metallurgical Divisions: **Horace B. Van Dorn,** director of engineering; **Howell L. Potter,** assistant director of engineering; **Francis G. Patterson,** chief product engineer; **A. Burton Jones, Jr.,** chief research engineer; **Henry Hubbell,** technical development manager; **Philip K. Pearson, Jr.,** chief plant metallurgist.

Alexander F. Brewer, technical director, Hughes Aircraft Co.'s Products Group, Los Angeles, Calif.

Phillip J. Stroh, product manager-aircraft maintenance, Kelite Corp., Berkeley Heights, N. J.

Lt. Col. Donald Williamson (USAF, ret.), small business coordinator, Georgia Division, Lockheed Aircraft Corp., Marietta, Ga.

Kimball C. Cummings, manager of engineering, Minneapolis-Honeywell's Beltsville, Md., division.

Sidney Herman, chief engineer, North Atlantic Industries, Inc., Westbury, N. Y.

William K. Ruediger, reservations manager-system, Pan American World Airways, Inc.

L. G. Becker, eastern regional manager for Philco Corp.'s Government & Industrial Division, Washington, D. C. Also: **George M. Rouzee,** sales manager for the division's Western Development Laboratories, Palo Alto, Calif. **Kenneth J. Evans** succeeds Mr. Rouzee as the Division's government sales manager-advanced military systems.

Richard W. Hanford has joined the engineering staff of Advanced Military Systems, Defense Electronic Products, Radio Corporation of America, Princeton, N. J.

Roy Steckmesser, field sales engineer, Servonic Instruments, Inc., Costa Mesa.

Gordon E. Stauffer, administrator for the B-70/F-108 pumping system program, Vickers, Inc., division of Sperry Rand Corp., Detroit, Mich.

Under flexing tests conducted by Wright Air Development Center engineers, this improved ducting showed no damage after 1,000 flexing cycles, 380-390F temperature, and 90-pound-per-minute air flow.

LIKE NEW AFTER 1000 FLEXING CYCLES

THERMOID-QUAKER jet-starter hose has exclusive government approval. Only Quaker jet-starter hose has government approval for use in starting jet engines. This new "Dacron"-and-silicone rubber hose is $200 cheaper for each 30-foot length. Yet it extends the life of pneumatic ducting from 200 to 5,000 engine starts.

It won't kink, because of cross-braid construction. Threads are crossed at right angles to one another to distribute the load in all directions. A scuff cover of porous netting is bonded at 2½-inch intervals to doughnut-like silicone scuffers.

Get complete information, including Technical Data, on Quaker jet-starter hose, from your local Thermoid industrial distributor, or write *Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.*

THERMOID PORTER DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

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Subject to Agency Commission.

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A nationally known California engineering organization needs additional engineering strength in the electronics field, because of recent expansion and continued diversification. They need engineers with demonstrated technical competence and leadership ability. These men are experienced in R & D guidance and controls with emphasis on electromechanical systems for extreme environmental conditions.

CHIEF ELECTRONICS ENGINEER

Support organization executives in management of electronic controls development. Should be experienced in electronic controls design and development.

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Requires a project engineer experienced in guidance and controls with one of the missile prime contractors.

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Management Consultants

936 Huntington Drive **San Marino, California**

ATlantic 4-4590

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FOR TWIN BEECH AIRCRAFT

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P. O. Box 231, Kingsport, Tennessee

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—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

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Space, ASW, and weapon system work at Vought requires continuous R & D in methods and materials, structures and design. These projects have prompted exploratory work in the following areas:

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Heat transfer, thermal stress and deflection analysis, and stress analysis using high-speed computers.

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Industrial Engineering
Project estimating, work sampling, line load and balance, and packaging and installation of new procedures.

Antisubmarine Warfare
Studies of detection and classification techniques involving Acoustics, Geomagnetism, Geophysics, Electromagnetics, Electrochemistry, Math.

Engineering Planning
Man-hour and budget forecasting, and project planning and scheduling.

Product Design
Automatic escape devices, atmospherically sound cockpits and advanced instrument displays for space pilot, crew.

Flight Test Instrumentation
R & D in new techniques for electronic gathering and reducing of flight test data.

Aerodynamics
Wind tunnel and model work employing Vought's 3,800-mph high-speed wind tunnel and new "high-temperature" laboratory.

Qualified applicants are invited to write:

J. W. Larson
Ass't Chief Engineer, Administrative Dept. M-32

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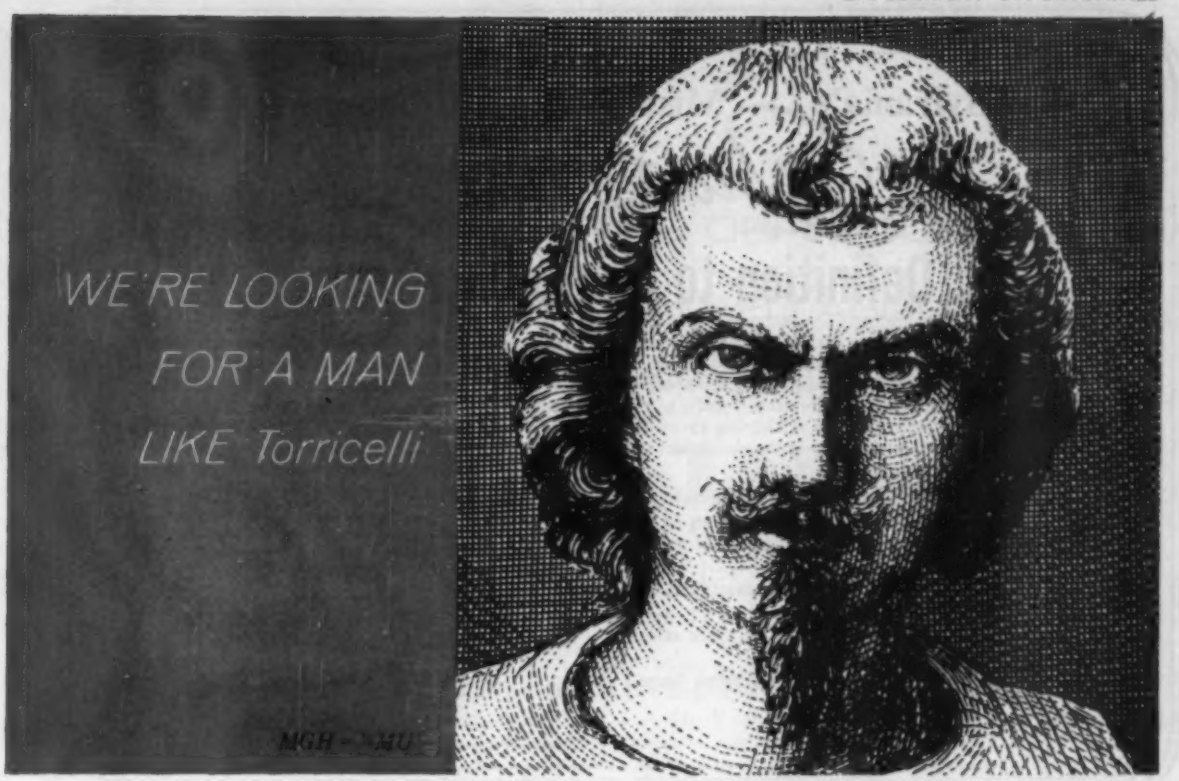
DALLAS, TEXAS



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*Also programs in rocket propulsion, interplanetary guidance, ground support systems for missiles, nose cones, radar structures, advanced black boxes, radomes and structures engineering.

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Add Definition to Unexplored Technology

ENGINEERS OF SUPERIOR disciplinary endowment with an interest in *adding definition to unexplored technological areas* will appreciate the scope of activity at the Missile Systems Laboratory. Typical of the programs now under way that are leading to revolutionary advances in the state-of-the-electronics art are:

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3. **Satellite Detection and Tracking Equipments** that compute orbital parameters
4. **Two-way Communication Systems** for space vehicle applications
5. **Ballistic Missile Detection and Interception Systems** incorporating advanced concepts

The opportunity to contribute to pioneering, long-term programs is just one of the many advantages found at the Missile Systems Laboratory. Located in suburban Boston – new world center of electronics – where great educational institutions, world famous scientists and active professional societies combine to create an environment that increases personal creativity and competence.

We invite you to inquire how your training and previous professional experience can qualify you for a career position with Sylvania. There are immediate openings at all engineering levels in the above areas.

Please send resume to Graydon A. Thayer
Waltham Laboratories / **SYLVANIA ELECTRONIC SYSTEMS**
A Division of
SYLVANIA
Subsidiary of GENERAL TELEPHONE & ELECTRONICS
100 First Avenue, Waltham 54, Massachusetts

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ASTRONAUTICS & AERONAUTICS
with Republic Aviation

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- VTOL and STOL aircraft
- Advanced combat and transport aircraft
- Air launched and ground launched missile systems
- Manned and un-manned satellites
- Interplanetary launching and recovery systems

Applicants should have 5 years' experience in the analysis of airframe and missile components. An ability to apply classical methods in determination of internal load distributions and stresses in complex structures is necessary. Familiarity with the effects of high temperature environment on structural material, design and analysis will be helpful.

You will work in Republic's new $14,000,000 Research Center scheduled for completion this year.

Send your resume in confidence to:
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Engineering Employment Mgr., Dept. IG-5
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Farmingdale, Long Island, New York

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Excellent opportunities for Sales Engineers with experience in propulsion, missile, or space systems and components.

Openings exist in South Bend, Ind. for men of proven capability with sales experience and technical background in the mechanical, electrical, and/or electronic fields. Assignments require knowledge of current propulsion, airframe and missile/space programs and will involve contacting industry and missile agencies.

Send complete resume to:

J. P. Makielski
Administrative Engineer
BENDIX PRODUCTS DIVISION
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SOUTH BEND, INDIANA

Systems
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MISSILE OF THEM ALL

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...and other diverse and complex weapons projects at General Electric's Ordnance Department in the Berkshires*

When the first operational Polaris missiles are installed in the "George Washington" —first atomic submarine specifically designed as floating platform for the Navy's undersea-launched IRBM s—it will be a day of great moment for the engineers and scientists at General Electric's Ordnance Department, who are now pouring their energies, imagination and technical skills into the development, design and production of Polaris Fire Control and Inertial Guidance Systems.

A day of celebration—but also one that ushers in new and other challenging problems—for the push to develop the next generation of long-range underwater ballistic missiles and kindred advanced weapons and weapon systems will be on.

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FIELD SERVICE & EVALUATION / QUALITY ASSURANCE & RELIABILITY ENGINEERING
ELECTRO-MECHANICAL DESIGN / ADVANCED PRODUCTION ENGINEERING
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Field Test Engineering (Florida, California and several naval stations in continental U.S.)
Also technician openings for graduates with missile experience

Write in strict confidence to: Mr. R. O'Brien, Dept. 64-WD
Ordnance Department of the Defense Electronics Division

GENERAL ELECTRIC

100 Plastics Avenue, Pittsfield, Mass.

* **Additional Projects Under Investigation at the Ordnance Department.** Urgent, vital and engrossing as the Department's share in the Fleet Ballistic Missile Program is, it is just one of the diverse activities here that today offer engineers a progression of challenging assignments on: **Atlas Guidance Equipment • Talos Handling and Launching Equipment • Advanced Torpedo Development • Tartar Fire Control**

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CONTROLS DEVELOPMENT— Opportunity to create workable controls components. Must have a "feel" for hardware and desire to undertake broad engineering responsibility. Opportunity to solve "on-the-spot" engineering problems utilizing pneumatic and hydraulic control analysis techniques.

For additional information, please write:

Mr. Floyd E. Hargiss, Manager
Professional Personnel, Dept. A-10
Marquardt Corporation
16555 Saticoy Street
Van Nuys, California

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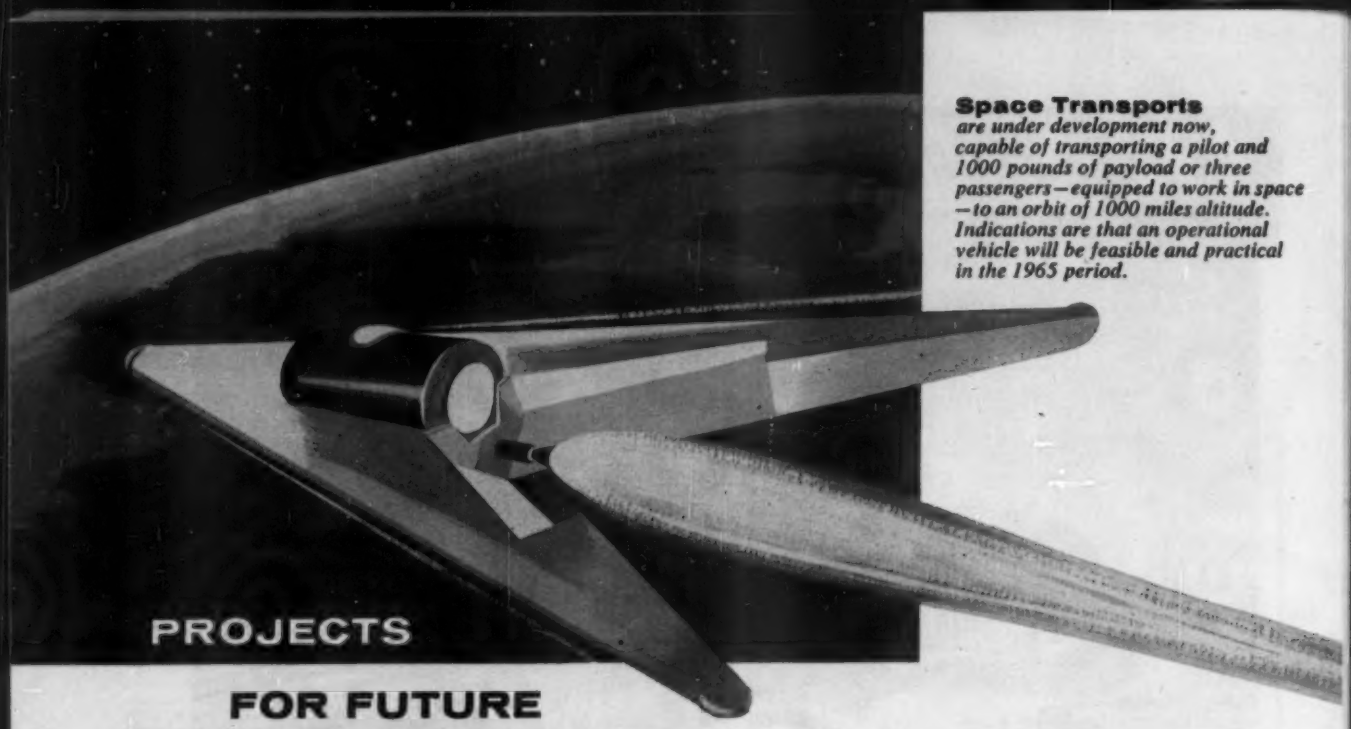

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Supersonic Transports—have held an important place in our thinking for the past several years. Extensive wind tunnel tests have been conducted on many design concepts, supplemented by exhaustive laboratory and structure studies. Lockheed is prepared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted using an advanced method of detecting fast-moving missiles and high-speed aircraft. A new facility, which includes an advanced laboratory, with an infrared tunnel, for basic research and development of prototype equipment in this expanding field, has been set up to push Lockheed, Burbank, to the forefront in infrared study.

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LETTERS

Quesada Blast

If what he stated was true, ". . . taken just about enough," it's a good thing Clarence (Clarence N. Sayen, Air Line Pilots Assn. president) canceled his subscription when he did (AW May 25, p. 150). If he had read the blast dealt by Mr. Quesada (AW June 29, p. 81), he would not only cancel his AVIATION WEEK subscription but he might even tell his mother.

DON WISNER
Windsor, Conn.

Pilot Respect

Since your publication is read by most of us in the industry, I would like to congratulate Mr. E. R. Quesada, Federal Aviation Agency administrator, publicly through your column. His reply to Mr. C. N. Sayen, president, Air Line Pilots Assn., ("Sayen, Quesada Debate FAA Cockpit Rule" (AW June 29, p. 79), is among the most smashing pieces of rhetoric I have ever encountered.

The airline pilot, as a species, has always enjoyed the unique niche of respect accorded to most of our professional society engaged in the more complicated and exacting vocations. They are looked upon by the general public as a capable, highly-trained, better-than-average group—a regard they most certainly have earned. It is extremely doubtful that this same general public is losing any of this faith in recent years. My own impression, as an interested and objective observer, is that this highly competent group is induling in some pretty slipshod organizational representation. Having a front man of the apparent careless verbosity of Mr. Sayen is causing them to lose points every time out. It would appear to me that ALPA presidents should just be diplomatic enough not to go handing out ultimatums to FAA directors. This just has to hurt every conscientious working pilot if the public is to assume the ALPA is, in fact, speaking their collective opinion.

None of us can possibly doubt that occurrences in flight, such as the two cases pointed out by Mr. Quesada, will simply go away or just stop happening—they are occupational hazards built into aircraft piloting. It is the resolving of these, after the fact, that requires the team effort. This is one of the reasons for the existence of both FAA and ALPA.

At that point, who ALPA puts up to speak for their side starts to attract the attention of us general public. Right now they had better monitor Mr. Sayen's mail or lock up his typewriter or something before us general public air travelers start downgrading airline pilots in general.

Speaking for myself, I'll fly anywhere, any time with an ALPA man up in the front office, and no sweat. But you guys better do something about your public relations.

EDWARD T. SHERMAN
Kollsman Instrument Corp.
Elmhurst, N. Y.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Aviation Industry

On p. 34 of your issue of June 1, there is an article in which you list the remuneration in 1958 of aircraft company officers and directors.

We wish to point out that Raytheon was erroneously included in this listing. Raytheon is, as indicated by the company's slogan "Excellence in Electronics," an electronics company, not an aircraft company.

RICHARD P. AXTEN
Director of Public Relations
Raytheon Manufacturing Co.
Waltham, Mass.

(With avionics companies like Raytheon holding important missile prime contracts and many aircraft companies moving into the avionics field, the line which separates aircraft and avionics companies is growing increasingly faint. However, Aviation Week concedes that the broader, all-encompassing term of "aviation industry" might better have been used for the article in question.—Ed.)

Domestic Routes

Concerning Robert H. Cook's article "CAB Lawyers Attack Airline Stock Deal" between National and Pan American (AW July 6, p. 41), my question is simple. Why? Why is the CAB so violently opposed to awarding a domestic route to Pan American?

There is only one airline in the world whose government consistently and violently forbids it to carry passengers and revenue within the borders of the country it represents.

The opposition screams monopoly, yet the other two large American flag international carriers, TWA and Northwest, also have extensive (and expanding) networks of domestic routes. Yet I and over 300 other flight crew members were furloughed by Pan American last year, and more layoffs are projected for later this year.

Equally as distressing is the slant of some of Mr. Cook's remarks. Some examples:

(1) "Pursuing their contention that Pan American's basic purpose in entering into the agreement with National was to gain control of a New York-Florida carrier, . . ." (Is this an illogical alternative when the government refuses to award PanAm a franchise for this route?)

(2) "(CAB) Bureau Counsel also questioned whether the CAB should permit 'special circumstances' which might force Northeast back on subsidy and pointed out that Pan American and National combined would have more assets, net worth and revenues than Eastern Air Lines would have." (First comment—After two years of Florida traffic, Northeast was already back on subsidy in 1958. Second comment—perish the thought that the government should even think of letting anyone exceed Eastern in assets, net worth and revenues!)

I ask again, why must the American government be so determined to keep an American air carrier from flying revenue within America?

Why?

ROBERT W. LEPPELMEIER
North Babylon, N. Y.

(Mr. Cook is reporting the opinions and actions of the CAB attorneys involved, not his personal "slant."—Ed.)

Trick Question

An airline passenger, Mr. Hans J. Maier, asks in your June 29 issue (p. 98), ". . . . which of the following two pilot groups is likely to provide safer jet airline operations: A. Existing airline pilots with adequate jet transition training, or B. Ex-military jet pilots (preferably multi-engine) with adequate airline transition training?"

This is a trick question because no definition of the word "adequate," in its aviation sense, is supplied with the question. Either group could equally qualify. It depends how one would apply the word "adequate."

Perhaps this opinion is not exactly what Mr. Maier had in mind when he mentioned an extensive pilot study. However, such a study would be merely academic. Group B wouldn't have a chance, anyway, except as it might have as part of Group A.

That's the system.

ROBERT E. TRIMBLE
Washington, D. C.

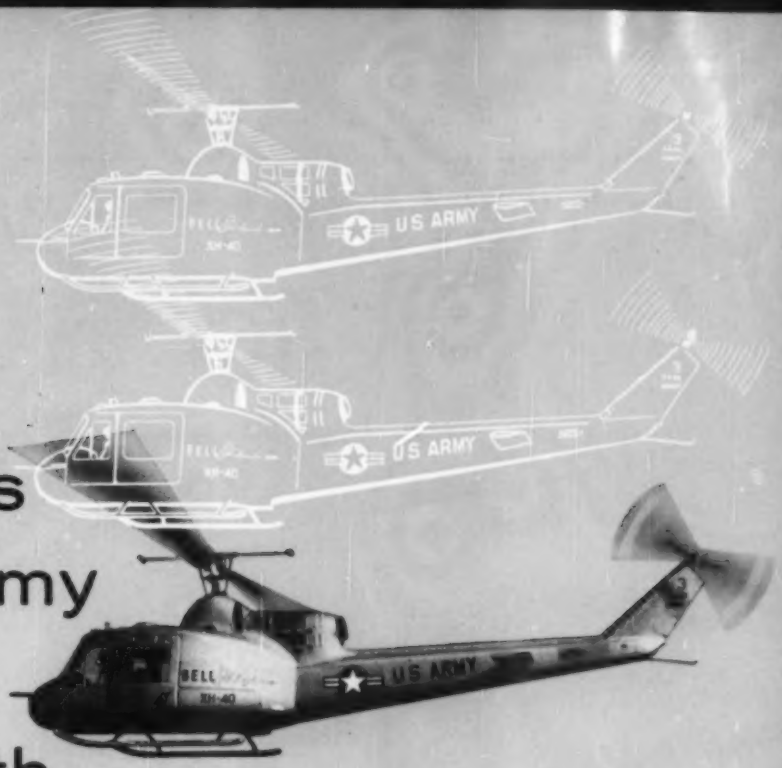
Flying Ball Teams

It was very nice of you to mention United Air Lines' baseball participation on p. 45 of your July 6 issue. However, for the record, I believe you would like to have a more accurate report of United Air Lines coverage in transporting various National and American leagues.

United Air Lines flies all 16 teams; all seven National League teams and two American League teams fly all season trips exclusively United. The Los Angeles Dodgers fly United on all long haul trips and their own Convair on shorter trips. The Indians, Red Soxs, Orioles and Senators fly United in varying amounts from 15 to 25 trips. The Athletics will fly United about one-half dozen trips this season as well as the Yankees.

All of the trips listed are by charter. The Athletics will fly about eight trips via TWA scheduled flights this season. To our knowledge, no other airline will be carrying major league baseball teams Thanks again for your acknowledging this very important service feature.

HARRY HORST
Sports Coordinator
United Air Lines, Inc.



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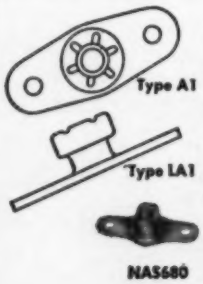

In 1931, the pioneers of the aviation industry were designing the first metal airplanes. One of the major assembly problems was the need for a safe, blind type of fastener which would permit assembly and disassembly of sections from the outer side. ESNA created a "special" part . . . the first two lug anchor nut.

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